NOV 8 1937

Heating · Piping and Air Conditioning

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PREFABRICATION BY GRINNELL

...WHENEVER PIPING IS INVOLVED...

The Editor's Page

■ **Differential in temperature** between artificially cooled restaurants, theaters, stores and other public gathering places and the temperature in the shade on the outside not less than 100 ft distant from the building was limited to not more than 15 deg in a regulation issued by the board of health of Cincinnati last December, and managers of theaters and other buildings were asked to cooperate. . . . During the hot weather last summer the board made a number of temperature tests but did not find any violations. According to J. S. Shuey, chief of the bureau of general foods and sanitation of the board, all the engineers conferred with agreed that they were able to meet the requirement as a rule by a slight change in the dew point and in the main were satisfied the regulation was reasonable and workable. . . . William B. Henderson, executive vice-president of the Air Conditioning Manufacturers' Association, believes that ordinances of this kind are valuable as a definite step "to end mis-use and incorrect operation" of air conditioning equipment.

■ **$40,000 for heating control** will result in an estimated saving of nearly $10,000 a year in the cost of heating the Merchandise Mart, Chicago, the "world's biggest building." . . . Eight "stats" placed outside the building will regulate the direct radiation in accordance with outside conditions. . . . The sales contract is unusual in that it calls for monthly payments equal to the saving effected during the previous month, savings to be based on previous records of coal consumption under similar weather conditions. . . . An article on the project and the contract by W. A. Stahl, operating engineer of the Mart, is planned for early publication in HEATING, PIPING AND AIR CONDITIONING.

■ **"Consider air conditioning** or aviation as a life work" Westinghouse vice-president A. E. Allen recommended to any young man who has an aptitude or liking for things electrical or mechanical at the opening session of the company's air conditioning application school last month. . . . Among the air conditioning authorities who addressed the students was Dr. E. Vernon Hill (see illustration).

■ **Installed cost** of equipment sold by the members of the Air Conditioning Manufacturers' Association in August totalled $3,269,792 as compared to $3,621,885 in August 1936, a decrease of 9.7 per cent, William B. Henderson, executive vice-president, has announced. It was the first decrease of the year below a 1936 comparison period. . . . "Seasonal trends moved forward this year, the great upturn of March and April coming, for example, at a time earlier than in previous years," Mr. Henderson said. "Another advance is expected for the final quarter of 1937." The 1937 total had reached $71,575,967 when his statement was made, virtually twice the $36,151,088 attained in the same months of 1936 and 43 per cent greater than for all 1936, when the manufacturers reported an installed cost aggregate of $49,942,301.

■ **Keynote speaker** for the 38th annual convention of the International Acetylene Association at Birmingham, November 10 to 12, will be Dr. James Shelby Thomas, president of the Chrysler Institute of Technology. . . . The subjects to be discussed at the meeting include speeding manufacture and construction with oxy-acetylene welding (with special attention to piping), how and why to use oxy-acetylene cutting, and maintenance and operations uses of the oxy-acetylene process. . . . A feature of the convention will be the round table discussions to be held in the evenings.

■ **"Conditioned air for winter driving"** tops the new developments that Nash is offering in its new cars. The system brings in cleaned warmed air and circulates it to "end drafts and eliminate window and windshield steaming." The unit, illustrated here, consists of an air filter with motor driven fan and hot water heating element mounted under the cowl and connected with the cowl ventilator. Moisture if it is raining, is "spun" out of the air and passes off through a vent pipe.

Dr. E. Vernon Hill explains some of the fine points of air conditioning to students at an air conditioning application school held last month.

■ **The first cast iron pipe** laid in Chicago—in 1854 on State St. between Monroe and Jackson—is being replaced by a new 16 in. line to reduce the cost of maintenance and also to increase capacity, because of the demand for water due to air conditioning which is increasing on State St. The original pipe was cast in Scotland and was in 9 ft lengths 12 in. in diameter with a reinforcing ring every 3 ft. . . . The work is part of a general plan to reinforce the water supply in various locations in the loop district as additional demands for water develop, according to Loran D. Gayton, city engineer.

Nash Motors' "conditioned air for winter driving" is provided by this unit. The black arrows indicate outside air which enters due to the forward motion of the car.

■ **Air conditioning trends** in a large city—Minneapolis—are analyzed in the current issue of "Air Conditioning Trends" issued by the publisher of HEATING, PIPING AND AIR CONDITIONING. The reported study disclosed a number of problems, including spotty penetration of the market—characteristic of large centers of population. . . . A summary of the market for air conditioning in the retail store field in Minneapolis discloses that on a conservative basis there are 750 such stores to which it is still possible to apply air conditioning.

■ **Over 26,000** was the total attendance at the Chicago Exposition of Power and Mechanical Engineering held during the first week of October. One hundred and fifty-three exhibitors cooperated to present an exposition characterized by dynamic displays featuring many varieties of equipment in operation.

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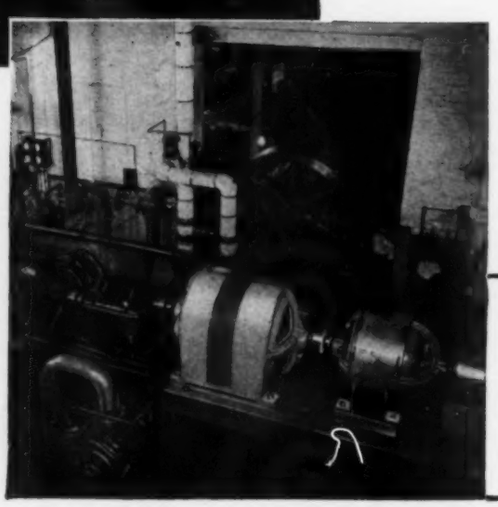

3. LOW POWER COSTS throughout the plant are assured with a set-up like this—and it's all a part of the heat balance made possible by Carrier Centrifugal Refrigeration. Only a fraction of the size of the equipment it replaces, this mixed pressure bleeder, type turbine and dual generator unit supplies both AC and DC power, and also provides clean exhaust steam for processing. Why install large, costly generators — when smaller ones supply all the electric power required, more efficiently — more economically?

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Lastly, the system requires less space and less attention. Using a low pressure harmless refrigerant, the Carrier Centrifugal operates at conservative speeds, picks up loads almost instantly, and meets all varying load conditions. A minimum of moving parts insures long, trouble-free service.

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CONTENTS *for* NOVEMBER, 1937

Volume 9 Number 11

Recent Changes in National Piping Standards, by Sabin Crocker and Harvey A. Wagner 659

The Owner's View of Air Conditioning, by J. J. Cogan 664

Blower Filter Unit Solves Press Room Problem, by F. S. Robinson 665

E. Vernon Hill's Personal Comments—Capacity Tests 666

What's the E.D.R. of Indirect Heating Surface?, by William S. Downs 667

New Data for Refrigeration Piping Design (Methyl Chloride Suction Piping), by R. C. Doremus 669

Don't Forget Air Conditioning Maintenance, by C. T. Baker 674

Electric Heating System Defrosts Store Windows, by W. F. Mainguy 675

Office Building Cleans Air Electrically 676

A Rule-of-Thumb for Scientific Duct Design, by Henry G. Schaefer 678

Builds Air Conditioned Film Warehouse, by H. W. Sachs 680

New York's New Building Code, by Walter L. Fleisher 682

How Steam Storage Can Be Applied to Process Steam Piping Systems 685

Selecting the Right Size Heating Boiler, by Sabin Crocker (H. P. & A. C. Summary Sheets) 687

Solving Piping Flow Problems, by William Goodman 689

Practical Standards for Air Conditioning Calculations, by W. S. Bodinus 693

Refutes Idea That Air Conditioning Will Cause Water Shortage 720

Booklets, Reports and Papers (back section) 122

Equipment Developments (back section) 130

Conventions and Expositions (back section) 148

Recent Trade Literature (back section) 148

Index to Advertisers (back section) 156

Journal Section of the American Society of Heating and Ventilating Engineers

Control of Body Heat Loss Through Radiant Means, by C. A. Mills and Cordelia Olge 697

Measuring Air Distribution and Grille Performance in Air Conditioning, by G. L. Tuve 700

Bulletin Section 703

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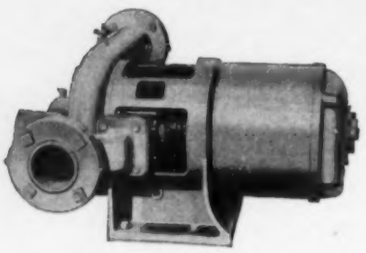

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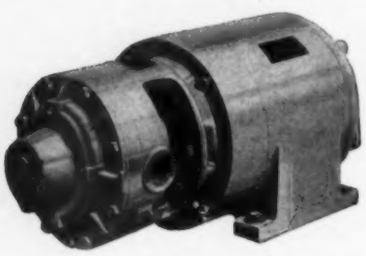

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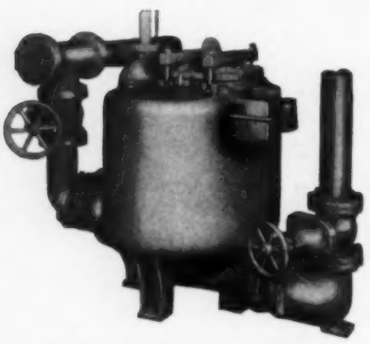

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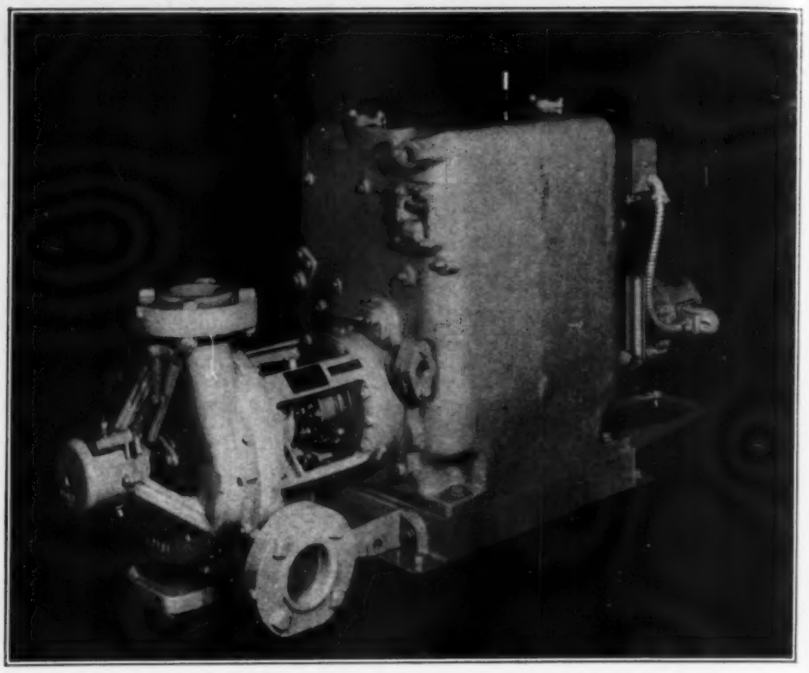

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Heating · Piping and Air Conditioning

Vol. 9. No. 11. ● *November, 1937*

Recent Changes in National Piping Standards

MATERIALS

By **Sabin Crocker* and Harvey A. Wagner†**

Numerous significant changes in national piping standards have taken place since a previous comprehensive review of the subject has appeared. Everyone concerned with piping will therefore welcome this thorough treatment of standards, for it is a means of posting oneself on what has been done, what is planned for the near future, and of becoming up-to-date on an increasingly important matter

THE past four years has seen considerable progress in the development of materials specifications for piping, particularly for high temperature service due largely, no doubt, to the increasing use of higher steam pressures and temperatures both by utilities and industrial plants. A brief resumé of the materials specifications available for service at temperatures up to 1100 F is given below:

Pipe: The Specification for Lap Welded and Seamless Steel Pipe for High Temperature Service, A106-36, was formulated back in 1929 when 750 F was a high temperature for a steam power plant. In view of the present-day trend, the terminology of the specification is somewhat misleading. The specification was extensively revised in 1933 to include supplementary requirements for pipe for use in central stations at pressures of 400 psi (pounds per square inch) or over and temperatures up to 850 F, or other applications where a superior grade of pipe is required. The only material covered, however, is plain carbon steel. In general, the supplementary tests prescribe a larger number of the same tests described in the regular specification although one extra test, the *etch test,* is included which is not prescribed in the body of the specification. When care is exercised in securing a high grade product in accordance with the supplementary requirements, the material is quite satisfactory up to 850 F, the maximum temperature recommended in the specification.

Since above this temperature the strength and creep resistance of carbon steel falls off so rapidly that its use becomes uneconomical, recourse to some low alloy steel is found desirable. The bulk of steam power plants now being built or contemplated will operate at steam temperatures below 1000 F. This permits use of a low alloy pipe, carbon-molybdenum, which has a similar chemical composition to A106 carbon steel pipe with the exception of the addition of 0.45 to 0.65 per cent molybdenum.

This addition, however, is sufficient to increase to a marked extent the ability of the steel to withstand steam temperatures up to 1000 F, although the molybdenum addition renders the steel somewhat more difficult to fabricate as compared to carbon steel. In view of the extensive use of carbon-molybdenum pipe in recent central stations, A. S. T. M. Specification A206-37T was drawn up to cover this product, which is known as the "Tentative Specifications for Seamless Carbon-Molybdenum Alloy Steel Pipe for Service at Temperatures from 750 to 1000 F." As in the case of A106 pipe, supplementary requirements for pipe for use in central stations at pressures of 400 psi or over and temperatures from 750 to 1000 F are included. Plain carbon steel is somewhat easier to weld than the carbon-moly product, although the latter is not difficult for experienced welders when proper precautions are observed.

In order to facilitate the manufacture and stocking of this pipe the Prime Movers Committee of the Edison Electric Institute agreed with the manufacturers on certain sizes and wall thicknesses for stock purposes. The economic reasons for this standardization were: (1) to facilitate delivery of pipe, particularly replacement orders; (2) to avoid a costly mill set-up of equipment to produce a small quantity of pipe. The thicknesses selected conform to the schedule thicknesses of American Standard B36.10-1935. These values, taken from an appendix to the specification which is stated to be for information only, are given in Table 6.

A third high temperature pipe specification is available in A. S. T. M. Specification A158 for Seamless Alloy Steel Pipe for Service at Temperatures up to 1100 F. Pipe covered in this specification ranges from low chromium-molybdenum alloys to the 18 per cent chromium,

*Engineer, The Detroit Edison Company. Mr. Crocker is a member of our Board of Consulting and Contributing Editors, secretary of A. S. A. Sectional Committee B86 on Pipe and a member of A. S. A. Sectional Committee B16 and of the A. S. T. M. committees on specifications for piping materials.

†Engineer, The Detroit Edison Company. Mr. Wagner has been associated with Mr. Crocker for the past ten years in the above mentioned committee activities, and is the author of several articles on various phases of piping standardization and design.

Part 2, Part 1 was published in the October, 1937, HEATING, PIPING AND AIR CONDITIONING, pp. 613-617.

Table 6—Stock Sizes for Carbon-Molybdenum Pipe[a]

Nominal Pipe Size	Service Up to 1400 psi at 950 F		Service Up to 900 psi at 900 F	
	Schedule Number[b]	Thickness Inches	Schedule Number[b]	Thickness Inches
¾	160	0.218	160	0.218
1¼	160	0.250	160	0.250
2½	160	0.375	160	0.375
4	160	0.531	120	0.437
6	160	0.718	120	0.562
8	160	0.906	100	0.593
10	160	1.125	100	0.718
12	160	1.312	100	0.843
14	160	1.406	100	0.937
16	160	1.562	100	1.031

[a]These sizes and wall thicknesses were agreed on for stock purposes by pipe manufacturers and the Prime Movers Committee of the Edison Electric Institute.
[b]Schedule numbers and thicknesses in accordance with American Tentative Standards for Wrought Iron and Wrought Steel Pipe, B36.10-1935.

8 per cent nickel varieties. These alloys are used where temperatures are in excess of those for which carbon-moly pipe is suitable, or when a corrosion resistant alloy is desired. The oil industry, for instance, has made use of considerable of the 4 to 6 chromium alloys owing to their superior corrosion resistance as well as sustained strength at high temperatures. Carbon-molybdenum steel is little, if any, better than carbon steel in its ability to resist corrosion, but for steam temperatures up to 950 F or thereabouts, this is not a serious problem and carbon-molybdenum alloy has been found satisfactory. For corrosive conditions in the oil industry or for high steam temperatures when oxidation is an important factor, the higher alloyed materials have found considerable use. Materials now covered in Specification A158 are given in Table 7.

Consideration is being given by the A. S. T. M. to formulation of materials specification for welding fittings. While this is not precisely a pipe specification, it is closely akin to it since many welding fittings are made from pipe. Others, however, are forged seamless from plates, some forged and welded, and still others cast. In the forged product, some are forged hot and others cold which involves the question of heat treatment. The A. S. A. subgroup formulating the dimensional data will co-operate with the A. S. T. M. committee in development of a materials specification to cover the several varieties of welding fittings.

Castings: As in the case of pipe, a specification for carbon steel castings has been available for many years in A. S. T. M. Standard Specification A95-36 for Carbon Steel Castings for Valves, Flanges, and Fittings for High Temperature Service, which formerly covered use at temperatures up to 750 F. A careful study of the material in conjunction with the dimensional data on castings contained in the American Standard for Steel Flanged Fittings and Companion Flanges indicated that carbon steel castings could be used successfully at temperatures up to 850 F for steam and 1000 F for oil provided suitable modifications in their ratings were made. These are shown in Table 1 (p. 614, October issue).

The higher ratings allowed for oil are in keeping with well established practice in that industry, which is justified, in part at least, on the grounds of refinery piping being intended for a shorter life before retirement through obsolescence than is the case with steam. Furthermore, refinery piping is said to be taken down periodically for inspection and cleaning, thus affording an opportunity to replace any questionable articles which might have been

Table 7—Chemical Compositions of Alloy Steel Pipe Materials for High Temperature Service from 750 to 1100 F
A. S. T. M. Specifications A158-37T

Class	*Ferritic Steels*					
Identification Symbol	P 3a	P 3b	P 5a	P 5b	P 5c	P 6
Grade	Chromium Molybdenum	Chromium Molybdenum	4 to 6 Per Cent Chromium	4 to 6 Per Cent Chromium	4 to 6 Per Cent Chromium[b]	13 Per Cent Chromium
Carbon, per cent	0.15 max.	0.15 max.	0.15 max. or 0.20 max.	0.15 max.	As specified 0.10 or 0.15 max.	0.12 max.
Manganese, per cent	0.40 to 0.60	0.30—0.60	0.50 max.	0.30 max.	0.50 max.	0.50 max.
Phosphorus, per cent	0.04 max.	0.03 max.	0.03 max.	0.03 max.	0.03 max.	0.03 max.
Sulfur, per cent	0.05 max.	0.03 max.	0.03 max.	0.03 max.	0.03 max.	0.03 max.
Silicon, per cent	0.45 to 0.75	0.50 max.	0.50 max.	1.00—2.00	0.50 max.	0.50 max.
Nickel, per cent						
Chromium, per cent	1.50 to 2.00	1.75—2.25	4.00 to 6.00	4.00—6.00	4.00—6.00	12.00 to 15.00
Molybdenum, per cent	0.60 to 0.80	0.45—0.65	0.45 to 0.65 [a]	0.45—0.65	0.45—0.65	
Tungsten, per cent			0.75 to 1.25 [a]			2.50 to 3.50
Titanium or Columbium					4 to 6 times Carbon 8 to 10 times Carbon	

Class	*Ferritic Steels*		*Austenitic Steels*		
Identification Symbol	P 11	P 12	P 8a	P 8b	P 8c
Grade	Chromium Molybdenum	Silicon Molybdenum	18 Chromium 8 Nickel	18 Chromium 10 Nickel [b]	18 Chromium, 8 Nickel, 2 Silicon
Carbon, per cent	0.15 max.	0.15 max.	0.07 max.	0.08 max.	0.25 max.
Manganese, per cent	0.30—0.60	0.30 max.	0.20 to 0.70	0.70 max.	0.50 to 0.70
Phosphorus, per cent	0.04 max.	0.04 max.	0.03 max.	0.03 max.	0.03 max.
Sulfur, per cent	0.05 max.	0.045 max.	0.03 max.	0.03 max.	0.03 max.
Silicon, per cent	0.50—1.00	1.15—1.65	0.75 max.	0.50 max.	1.00 to 3.00
Nickel, per cent			8.00—10.00	9.00—12.00	8.00—10.00
Chromium, per cent	1.00 to 1.50		17.00—20.00	17.00—19.00	17.00 to 19.00
Molybdenum, per cent	0.45 to 0.65	0.45—0.65			
Tungsten, per cent					
Titanium, or Columbium				0.35 min. 8 times carbon content, min.	

(*) Either molybdenum or tungsten shall be used.
(*) Stabilized with titanium or columbium.

Table 8—Chemical Compositions of Alloy-Steel Castings Materials for High Temperature Service from 750 to 1100 F A. S. T. M. Specifications A157-36

Class	*Ferritic Steels*						*Austenitic Steels*	
Identification Symbol	C1	C2	C4	C5	C6	C11	C9[c]	C10
Grade	Carbon Molybdenum	Manganese Molybdenum	Nickel-Chromium Molybdenum	4 to 6 Per Cent Chromium	13 Per Cent Chromium	Nickel-Chromium	18 Per Cent Chromium 8 Per Cent Nickel	20 Per Cent Nickel 8 Per Cent Chromium
Carbon, per cent	0.45 max.	0.35 max.	0.45 max.	0.15—0.35	0.15 max.	0.45 max.	0.15 max.	0.35 max.
Manganese, per cent	1.00 max.	1.00—1.60	1.00 max.	1.00 max.	0.75 max.	1.00 max.	1.00 max.	1.50 max.
Phosphorus, per cent	0.05 max.	0.05 max.	0.05 max.	0.05 max.	0.05 max.	0.05 max.	0.05 max.	0.05 max.
Sulfur, per cent	0.06 max.	0.06 max.	0.06 max.	0.06 max.	0.05 max.	0.06 max.	0.05 max.	0.05 max.
Silicon, per cent	0.20 min.	0.20 min.	0.20 min.	0.20 min.	1.00 max.	0.20 min.	2.00 max.	2.00 max.
Nickel, per cent	.....	.....	0.75—1.50	.....	0.80 max.	1.00—2.25	8.00 min.	19.00—22.00
Chromium, per cent	.....	.....	0.50—1.00	4.00—6.50	11.5—13.5	0.50—1.00	18.00 min.	8.00—10.00
Molybdenum, per cent	0.40 min.	0.20 min.	0.30—0.60	0.40—0.65[b]	0.50 max.	0.20—0.40[a]	As agreed	.....
Tungsten, per cent	.....	.....	.....	0.80—1.25[b]	.....	0.40—0.80[a]	upon	.....

[a]Either molybdenum or tungsten may be used if desired.
[b]Either molybdenum or tungsten shall be used.
[c]For the more severe general corrosive conditions, and when so specified, the carbon content shall not exceed 0.07 per cent.
The addition of such elements as molybdenum, tungsten, titanium, columbium, and vanadium for purposes of stabilization shall be a matter of agreement between the manufacturer and the purchaser.
When the purchaser requires free-machining or better non-seizing, non-galling properties, the composition may contain suitable combinations of selenium and phosphorus or molybdenum and sulfur.

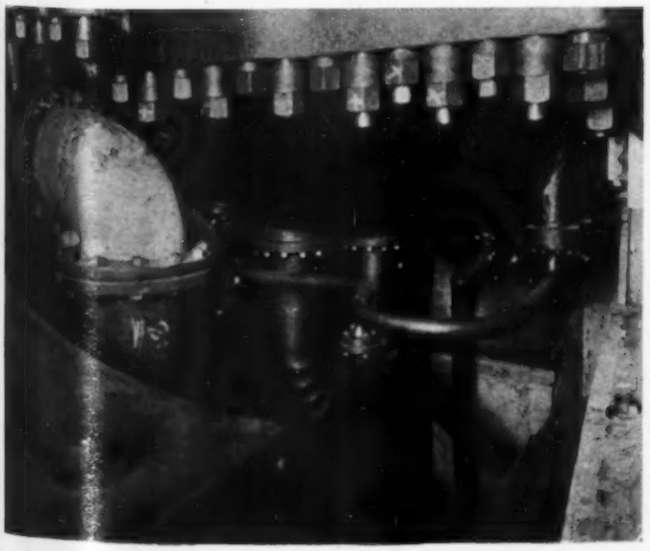
Selenium and Phosphorus	Selenium, per cent	0.20 to 0.35
	Phosphorus, per cent	0.17
Molybdenum and Sulfur	Molybdenum	0.40 to 0.60
	Sulfur	0.20 to 0.40

damaged through too prolonged exposure to high temperature or corrosive conditions.

To supplement carbon steel castings for service temperatures above the 750 to 850 F range, A. S. T. M. Specification A157 for Alloy Steel Castings for Valves, Flanges, and Fittings for Service at Temperatures from 750 to 1100 F was formulated. Eight alloys are included ranging from the lower alloyed carbon-molybdenum to a 20 per cent nickel, 8 per cent chromium alloy. Chemical requirements and physical properties of the alloys covered in this specification are shown in Tables 8 and 9. Selection from the alloys, as in the case of pipe, depends on the service conditions involved.

Forgings: Specifications available for forgings parallel those for castings, that is, the Specifications for Forged or Rolled Steel Pipe Flanges for High Temperature Service which covers two classes of carbon steel for maximum temperatures of 750 to 850 F, A. S. T. M. Designation A105-36, and the Specifications for Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for Service at Temperatures from 750 to 1100 F, which covers ten grades of alloy steels, A.S.T.M. Designation A182-36.

Bleeder steam connections at Conners Creek power plant



A new specification, Forged or Rolled Steel Pipe Flanges for General Service, A. S. T. M. Designation A181, was formulated and published in 1935 to meet the need for pipe flanges for general service. Both Specifications A105 and A182 require heat treatment of forged steel flanges to insure a high quality product. For the bulk of low pressure general service work, this is an unnecessary expense and hence the requirement was eliminated in the new specification.

Bolting: A recent article published in Heating, Piping and Air Conditioning considered in detail bolts and nuts for high temperature work.[3] Since that time, however, several important revisions to the new alloy steel bolting specification have been effected.

As a companion specification for the carbon steel pipe, castings, and forgings specification, A. S. T. M. Specification A96 for Alloy Steel Bolting Material for High Temperature Service has been very useful. The maximum temperature contemplated at the outset was 750 F although this later was extended to 850 F. Considerable latitude was allowed the manufacturer in supplying bolts

[3]"Nut and Bolting Materials for High Pressure and High Temperature Piping Service," by Harvey A. Wagner, Heating, Piping and Air Conditioning, March, 1937, pp. 147-151.

Table 9—Physical Properties[a] of Alloy-Steel Castings Materials for High Temperature Service from 750 to 1100 F A. S. T. M. Specifications A157-36

	Tensile Strength Lb per Sq In.	Yield Point Lb per Sq In.	Elongation in 2 In. Per Cent	Reduction of Area Per Cent
Grade C1	80,000	50,000	22.0	45.0
Grade C2	90,000	60,000	22.0	45.0
Grade C4	100,000	65,000	18.0	30.0
Grade C5	100,000	65,000	18.0	30.0
Grade C6	85,000	55,000	20.0	40.0
Grade C11	100,000	65,000	18.0	30.0
Grade C9	70,000	30,000	35.0	40.0
Grade C10	65,000	30,000	30.0	35.0

[a]When material is ordered for welding fabrication, chemical and physical requirements shall be a matter of agreement between the purchaser and the manufacturer.

in accordance with this specification in that no definite chemical compositions were included. Nickel, chrome-nickel, chrome-vanadium, chrome-manganese, or any other types of alloy steel approved by the purchaser may be furnished under the specifications.

For the more severe service at temperatures above 750 to 850 F, however, it was considered desirable to formulate a separate specification to include chemical and physical requirements of the individual alloys covered, since the higher pressure and temperature service warrants a more careful selection and inspection of materials. Table 10 shows the chemical properties and Table 11 the physical requirements of the alloys included in the new bolting specification, A193-37T. While no definite high temperature data are included in the specification at the present time, the addition of such information when available will be more readily accomplished through having a separate specification for high temperature material. Inclusion of physical property values in the specification will aid on inspection in securing a uniform material. In addition, the engineering designer will have, for the first time, data available on which to select a bolting material to resist the stresses incurred in initially setting up the joint. Intelligent selection of a material to withstand the gradual relaxation due to creep at the higher temperatures is hampered by the lack of data relative to the creep strength of these materials. It is hoped that influence of the various factors affecting creep will be better defined and that more creep data on commonly used alloy steels will be available in the near future.

Materials for nuts are covered in the specifications for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service to 1100 F, A. S. T. M. Designation A194-36T, which was discussed in the article[8] previously referred to. No revisions have been made in this specification since its publication in 1936.

Table 10—Chemical Compositions of Alloy-Steel Bolting Materials[a] for High Temperature Service from 750 to 1100 F Metal Temperatures

A. S. T. M. Specifications A193-37T

Class	*Ferritic Steels*					
Identification Symbol	B4	B5	B6	B7	B7a	B11
Grade	Nickel-Chromium Molybdenum	4 to 6 Per Cent Chromium	13 Per Cent Chromium	Chromium Molybdenum	Chromium High Molybdenum	Tungsten-Chromium Vanadium
Carbon, per cent	0.35—0.45	0.35 max.	0.12 max.	0.35—0.45	0.35—0.45	0.40—0.50
Manganese, per cent	0.50—0.80	0.30—0.50	0.60 max.	0.60—0.90	0.60—0.90	0.20—0.40
Phosphorus, max., per cent	0.04	0.03	0.140[c]	0.04	0.04	0.04
Sulfur, max., per cent	0.05	0.03	0.500[c]	0.06	0.05	0.04
Silicon, per cent		0.50 max.	0.50 max.	0.15—0.25	0.15—0.25	0.15—0.30
Nickel, per cent	1.50—2.00					
Chromium, per cent	0.50—0.80	4.00—6.00	11.5—13.0	0.80—1.10	0.80—1.10	1.00—1.50
Molybdenum, per cent	0.30—0.40	0.45—0.65[b]		0.15—0.25	0.45—0.65	
Tungsten, per cent		0.75—1.25[b]				1.70—2.30
Vanadium, per cent						0.20—0.30

Class	*Ferritic Steels*				*Austenitic Steel*
Identification Symbol	B12	B13	B14	B15	B8
Grade	Nickel-Chromium	Tungsten Molybdenum Chromium	Chromium Molybdenum Vanadium	Silicon-Chromium-Molybdenum	18 Chromium 8 Nickel
Carbon, per cent	0.35—0.45	0.30—0.40	0.35—0.50	0.40—0.50	0.07 max.
Manganese, per cent	0.60—0.90	0.60—0.90	0.40—0.70	0.40—0.70	0.20—0.70
Phosphorus, max., per cent	0.04	0.04	0.04	0.03	0.140[c]
Sulfur, max., per cent	0.05	0.04	0.05	0.03	0.500[c]
Silicon, per cent		0.15—0.30	0.15—0.30	0.50—0.80	0.75 max.
Nickel, per cent	1.00—1.50				7.00—10.0
Chromium, per cent	0.45—0.75	0.45—0.75	0.80—1.10	1.00—1.50	17.0—20.0
Molybdenum, per cent		0.40—0.65	0.30—0.40	0.40—0.60	
Tungsten, per cent		0.85—1.35			
Vanadium, per cent			0.20—0.30		

[a] As these steels are not necessarily all suitable for the full range of temperatures up to 1100 F, care should be exercised in making the selection.
[b] Either molybdenum or tungsten shall be used as specified.
[c] Where phosphorus exceeds 0.045 per cent, sulfur shall not exceed 0.050 per cent. Where sulfur exceeds 0.050 per cent, phosphorus shall not exceed 0.045 per cent. These limits of phosphorus and sulfur shall apply unless otherwise specified.

New Specifications for Boiler Tubes

Increasingly higher pressures and temperatures in power plants have required a corresponding development of boilers suitable for the service conditions. Several new specifications for boiler tubes have been or are being developed by the A. S. T. M. to meet the new conditions, reference to which is included here as of interest to the piping designer and engineer.

Up to 1935, the only A. S. T. M. Specification available for purchase of boiler tubes was that for Lap Welded and Seamless Steel and Lap Welded Iron Boiler Tubes, A. S. T. M. Designation A83. In view of difficulties experienced in securing satisfactory heavy wall tubes which were necessary to meet the higher pressures, such as lack of uniformity in hardness and excessive hardness, a new specification was developed. This is the Specification for Seamless Steel Boiler Tubes for High Pressure Service, A. S. T. M. Designation A192-36T. This specification was prepared to meet the more exacting requirements for high pressure boiler service which were not covered to the desired extent by the general specifications for boiler tubes, A83.

One of the innovations in this specification involves the new standard wall thicknesses for tubes. It has been common practice and the accepted standard system for many years to refer to Birmingham Wire Gages for tube thicknesses, even though it has long been recognized that the increments or steps between gages were extremly nonuniform. Since the boiler manufacturer or designing engineer ultimately had to convert the gages to decimal thicknesses, it was proposed to designate wall thicknesses directly in decimals of an inch with certain uniform increments between thicknesses. In order to satisfy those who have been in the habit of specifying tube thicknesses by means of "B. W. G.'s," increments in thickness were selected to conform as nearly as practicable to the B. W. G.

thicknesses without destroying the logical progression in tube wall thickness.

Table 11—Physical Properties of Alloy-Steel Bolting Materials for High Temperature Service from 750 to 1100 F Metal Temperatures

A. S. T. M. Specifications A193-37T

Grade	Diameter, Inches	Minimum Draw Temperature, F	Tensile Strength, Lb per Sq In.	Yield Point Lb per Sq In.	Elongation in 2 In., Per Cent	Reduction of Area Per Cent
B4	2½ and under	1000	160,000	135,000	14	45
		1100	140,000	120,000	15	50
		1200	125,000	105,000	16	50
Nickel-Chromium-Molybdenum	Over 2½ to 4, incl.	1000	155,000	130,000	14	45
		1100	135,000	115,000	15	50
		1200	120,000	100,000	16	50
B5	2½ and under	1000	120,000	95,000	15	45
		1100	110,000	90,000	16	50
		1200	100,000	85,000	17	55
4 to 6 per cent Chromium	Over 2½ to 4, incl.	1000	105,000	85,000	15	45
		1100	100,000	80,000	16	50
		1200	95,000	75,000	17	55
B6	2½ and under	1000	150,000	125,000	13	45
		1100	120,000	100,000	15	50
		1200	105,000	85,000	17	55
13 per cent Chromium	Over 2½ to 4, incl.	1000	140,000	120,000	13	45
		1100	115,000	95,000	15	50
		1200	100,000	80,000	17	55
B7	2½ and under	1000	135,000	115,000	15	50
		1100	125,000	105,000	16	50
		1200	105,000	90,000	17	55
Chromium Molybdenum	Over 2½ to 4, incl.	1000	125,000	105,000	15	50
		1100	115,000	95,000	16	55
		1200	105,000	85,000	17	55
B7a	2½ and under	1000	135,000	115,000	15	50
		1100	125,000	105,000	16	50
		1200	105,000	90,000	17	55
Chromium High Molybdenum	Over 2½ to 4, incl.	1000	125,000	105,000	15	50
		1100	115,000	95,000	16	55
		1200	105,000	85,000	17	55
B11	2½ and under	1000	210,000	190,000	11	35
		1100	205,000	180,000	12	35
		1200	185,000	165,000	13	40
Tungsten-Chromium-Vanadium	Over 2½ to 4, incl.	1000	205,000	185,000	10	35
		1100	200,000	175,000	11	35
		1200	180,000	160,000	12	40
B12	2½ and under	1000	125,000	105,000	16	50
		1100	115,000	95,000	17	50
		1200	105,000	85,000	18	55
Nickel-Chromium	Over 2½ to 4, incl.	1000	120,000	100,000	16	50
		1100	110,000	90,000	17	50
		1200	100,000	80,000	18	55
B13	2½ and under	1000	155,000	130,000	14	45
		1100	135,000	115,000	15	50
		1200	120,000	100,000	16	55
Tungsten-Molybdenum-Chromium	Over 2½ to 4, incl.	1000	145,000	120,000	14	45
		1100	125,000	105,000	15	50
		1200	115,000	95,000	16	55
B14[a]	2½ and under	1000	145,000	120,000	14	45
		1100	135,000	115,000	15	45
		1200	125,000	105,000	16	50
Chromium-Molybdenum-Vanadium	Over 2½ to 4, incl.	1000				
		1100				
		1200				
B15	2½ and under	1000	160,000	135,000	14	45
		1100	140,000	120,000	15	50
		1200	125,000	105,000	16	50
Silicon-Chromium-Molybdenum	Over 2½ to 4, incl.	1000	155,000	130,000	14	45
		1100	135,000	115,000	15	45
		1200	120,000	100,000	16	50
		AUSTENITIC STEEL				
B8 18 Chromium 8 Nickel	All Diameters	2000F Water Quench	75,000	30,000	35	50

[a]This material has been given a special normalizing treatment.

Another departure from the older specification concerns the method of specifying the tolerance on over-thickness. On hot finished tubes, for instance, it has been customary to permit an over-thickness tolerance of three gages, with corresponding variations in thicknesses of from 26 to 42 per cent. Specification A192 now specifies the over-thickness to be not in excess of 28 per cent for any tube, which will simplify the inspector's job considerably—particularly in the case of tubes the wall thicknesses of which do not coincide exactly with one of the B. W. G. thicknesses.

As a means of overcoming non-uniformity, the new specification provides for a larger number of tests than specified in A83 and includes a Rockwell or Brinell test on 5 per cent of all the tubes to determine conformance with prescribed hardness limits in the specification. A192 also contains provision for annealing of tubes if requested by the purchaser. This will enable securing tubes of a definite uniform hardness to meet the specific requirements of the exacting purchaser.

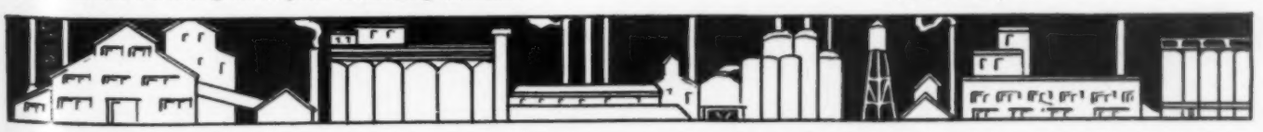
A few boilers are being built for pressures in excess of 2000 psi. For these extremely high pressures, if boiler tubes were made of ordinary Grade A material they would have such heavy walls that bending and expanding into headers and drums would become complicated and troublesome problems. For this reason, the A. S. M. E. boiler code committee requested the A. S. T. M. to prepare a new specification for Grade C tubes, or to expand the present requirements contained in A83 along somewhat similar lines to those now contained in A192. The new specification is to provide for heat treatment of the tubes to secure uniformity without excessive hardness, and to include a sufficient number of tests to insure receipt of a quality product.

The higher temperatures have necessitated use of alloy tubes in the superheaters of many boilers. As in the case of pipe, when temperatures are not likely to be in excess of 950 to 1000 F, carbon-moly tubing has found considerable favor. Above these temperatures, however, some of the more highly alloyed materials usually are employed, although the 18-8 type is employed only in special instances on account of cost. An important factor in the selection of a material for superheater use concerns the steam distribution in the unit; faulty distribution may result in much higher tube temperatures than anticipated and certain allowances in selection of tube materials must be made for this contingency.

To provide for the increasing use of alloy steel boiler tubes, two new specifications are being formulated by the A. S. T. M., one for carbon-molybdenum tubing, the other to include several grades of more or less commonly used alloys ranging from the lower alloy types to the 18 chromium, 8 nickel group. These specifications probably will be published in the tentative form in 1938.

In conclusion, while not all of the changes and additions to dimensional standards and specifications will be immediately available, it is felt that a summary of contemplated new features will be of interest to many, and that a broader dissemination of this information will be of assistance to all concerned.

[Concluded]



"Follow the crowds to Macy's" is a slogan in which air conditioning plays a part

The Owner's View of Air Conditioning

R. H. Macy & Co., Inc.—Department Store

FOLLOW the crowds to Macy's" is a slogan that is particularly appropriate, for Macy's and crowds have always been synonymous. That people in such great numbers have been attracted to this New York store has been due in great part to the position of leadership it has held during the 79 years of its existence.

In air conditioning, Macy's was among the pioneers. During 1929, when air conditioning was far from being the competitive necessity it is today, R. H. Macy & Co. made its first installation. At that time, only the basement and street floors were conditioned—a total floor area of 166,000 sq ft. However, this was found to be so satisfactory that in 1936 air conditioning was extended to the second, third and fourth floors. The complete installation, which covers a floor area of more than 500,000 sq ft, represents an investment of over $1,250,000. During the course of this work a tremendous amount of new ducts were installed without interfering with regular business operations and without causing any appreciable merchandise damage.

The installation of air conditioning in a large department store, with its wide floor areas, varying ceiling heights, differences in density of congestion between one section and another, with the accompanying differences in the amount of natural body heat released, presents problems not encountered in smaller establishments. When Macy's decided to venture into this field, it was their good fortune to have the services, as consultant engineer, of a foremost authority on ventilation. Having been associated with the store for a number of years, he was already familiar with the construction of the building and its problems, and was able to design a system to meet its particular requirements.

Since the development and inauguration of this system, the store has been not only satisfied with, but proud of, its recognized accomplishments.

1500 Tons of Refrigeration

The system itself is of the air washer type, and includes three centrifugal refrigerating machines with a total capacity of over 1500 tons. The chilled water is sent to 16 washing chambers on the various conditioned floors.

There are many economical features of the system. Four cooling towers on the roof cool the condenser water and permit its continued re-use in the refrigerating process. While it is necessary to replace only the water lost through these towers due to evaporation, the cost is lessened by using the excess from the circulating water —this excess being the result of the removal of moisture from air in the washing chambers. Economy is also effected in the operation of the three refrigerating units, as the high pressure turbine that drives one of the machines furnishes exhaust steam to the two low pres-

sure turbines on the smaller machines. Although the exhaust steam thus supplied is not quite sufficient, the difference is made by using exhaust steam from reciprocating engines in the generating plant.

The facts that the system distributes 583,000 cfm of air—that 4000 gpm of water is pumped to the air washers—and that the cooling towers handle 3200 gpm of water—give a good picture of the size of our operations in conditioning air.

Macy's Operating Policy

To the average layman, air conditioning usually means air cooling. He speaks of "cooling systems" and believes that cooling is the only function necessary. He is impressed only by the reductions in temperature that can be accomplished, thinking, of course, in terms of dry-bulb temperatures. Actually, air conditioning is of much broader scope, cooling being only one phase. In summer the prime factor is dehumidification, in order to give the refrigerating system of the human body a chance to operate efficiently, and in winter, humidification, that body heat may be conserved.

By J. J. Cogan*

As the result of its own experience, R. H. Macy & Co. is a firm advocate of air conditioning, and would advise its installation in any large department store situated in a climate similar to New York—especially in any new building about to be constructed . . . What a large drug store operator (Walgreen) thinks of air conditioning was described in September, and similar reports are in preparation for future issues

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These and other factors that govern the regulation of air are given full consideration in the Macy policy of operation, so that conditions may be achieved most satisfactory to human health and comfort. No attempt is made to be impressive, as the degree of difference between outside and inside air temperatures is only incidental to the conditions attained by the consideration of all factors involved. The system is in operation during the entire year. In summer, the air is filtered, dehumidified and cooled—in winter it is filtered, humidified, and heated. Careful attention is given to the maintenance of an even distribution, and remarkably few complaints are received from either staff or customers as to drafts, chills, or colds.

As atmospheric conditions change from time to time during the course of a day, it is necessary to keep abreast of these variations. Situated in the central plant are instruments and equipment which give great mobility of operation in meeting such changes. There is an instrument from which can be read remotely both the outside temperature and the wet- and dry-bulb temperatures at any of several strategic points on each conditioned floor. Hourly readings are taken from this instrument as a matter of routine. However, readings can be taken at any time if a sudden change in conditions is reported. Another facility for quick operation is the system of remote pushbutton controls for automatic starting and stopping of blower fans and air washer pumps.

*Assistant General Manager, R. H. Macy & Co., Inc.

Advantages of Air Conditioning

R. H. Macy & Co. has been thoroughly pleased with the beneficial results of air conditioning. While the importance of these benefits is recognized, it is not possible definitely to measure their effect because of other factors involved.

That it has had its effect on sales volume and profits is beyond question. Customers, naturally are pleased to be able to shop under such pleasant circumstances, and in all probability, spend more time and make more purchases than they would otherwise. Employees, too, feel fortunate in being able to work under these comfortable conditions, and their attitude is reflected by the type of service they are able to render.

As hasty purchases made in a humid, uncomfortable atmosphere, trying to the patience of both customers and sales people, would tend to increase the possibilities for complaints, the elimination of these conditions consequently has a favorable effect on the adjustment situation.

To some extent it has prevented losses of stock from deterioration. Since the air in the system is purified, and as it is necessary for efficient operation to keep all windows closed, there is no infiltration of outside air containing soot or other unclean particles which might soil merchandise.

As the result of its own experiences, and because of the trend of the times, R. H. Macy & Co. is a firm advocate of air conditioning generally, and would advise its installation in any large establishment situated in a similar climate—especially in any new building about to be constructed.

Blower Filter Unit Solves Press Room Problem

By F. S. Robinson*

A SPECIALLY designed blower filter unit has solved a troublesome manufacturing problem in the press room of Benham and Munday, Indianapolis printers.

Spray guns were recently installed over the presses to prevent offset, and while they accomplished the objective, they introduced a lot of new troubles. The material sprayed on the sheets left the nozzles of the guns wet and immediately became a dry powder. Most of it never reached the printed sheet but drifted into the atmosphere of the shop, settled everywhere, piled up on the presses, into the ink, and on the rollers. It penetrated into the office and the files and although the material used was known to be harmless, the constant irritation of it brought complaints from the employees.

Exhausting the surplus floating material to the outside would not do because the constant replacement of the air was disastrous to a close control of humidity and would add a large amount to the cost of winter heat (80 F is maintained during the heating season).

[Concluded on page 686]

*Schwitzer-Cummins Co.

E. Vernon Hill's* Personal Comments

Capacity Tests

EARLY last summer we had occasion to write specifications for the installation of cooling systems in three Chicago theaters. The systems as designed consisted of "Freon" compressors with direct expansion coils for air cooling. The tonnage on one installation was 85, the second was 100 tons, and the third 130 tons.

The contractor was required to guarantee the tonnage delivered in each case, taking into consideration the equipment as it would be operated in service, at a definite speed, with a definite air supply, and considering the compressors, condensers, expansion valves, expansion coils, and piping as a complete unit.

We have had experience on previous jobs where a definite tonnage was specified, but the method of determining the tonnage delivered was not. In this case, therefore, it was clearly stated in the contract that the tonnage was to be determined by the number of Btu's represented in the weight times the temperature rise of the condenser water, less 20 per cent for heat of compression. The specifications also called for the demonstration of tonnage to be made with the specified volume of air at a wet bulb temperature of 75 F.

Having everything nailed down tight in the specifications and in the contract we could foresee no condition that would cause argument. However, what with delays of one kind and another—delays in wiring the motors, broken suction valves, a burned out motor on a hot Sunday night, and other difficulties that had to be surmounted before the installations were ready for test—we finally realized that there would be very little more hot weather and probably no wet bulb temperature of entering air of 75 F until next summer.

We tried to produce a 75 F wet bulb temperature with artificial heat but the facilities were inadequate. We also endeavored to make tests at 70 F and later at 65 F wet bulb, and from the performance under these conditions to calculate what the tonnage would be with a wet bulb temperature of the entering air at 75 F. The results, however, were not convincing as there were so many variables in the problem. Finally it became evident that tests to demonstrate the tonnage of the compressors which would convince the owner he had actually obtained what he had intended to purchase must be delayed until next year.

This situation is unfortunate; it ties up a considerable amount of the contractor's money and is not conducive to the best of feelings for all parties interested.

Difficulties of this kind are not uncommon and it seems to me that they should not be necessary. If we assume that the compressor, condenser, expansion coils, and other essential parts of the cooling equipment are adequate to deliver the specified tonnage with a wet bulb of the entering air at 75 F why is it not possible to calculate the tonnage that would be delivered with the same equipment, the same condenser water, and the same air volume at an entering air temperature of 70 F wet bulb, also 65 and 60, and then plot a curve from these data that could be used for testing the installation at any wet bulb temperature within the range of the curve?

Of course there are a number of variables. The suction pressure changes with a lowered wet bulb temperature of entering air; the refrigerant temperature changes with the lower wet bulb temperature; the temperature of the condenser water does not remain the same. The problem therefore presents complications. It is extremely difficult to make accurate tests in the field at a lower wet bulb and interpret the findings in terms of a wet bulb of 75 F, but it seems to me that data from laboratory tests on coils and compressors could be furnished that would be sufficiently accurate for the purpose.

The problem is one which I think should be seriously considered; it is information that the engineer in the field sorely needs. I am reasonably sure that it can be solved. In fact, Bill Goodman was kind enough to tell me how to do it. He included in his letter all the necessary formulas, but there were so many logs, anti-logs, experimentally determined constants, and varying load factors that I hesitated—in fact, I decided not—to attempt it in the field.

If further investigation of the subject develops obstacles that are not at present apparent we can consider another avenue of approach: With the necessary information on the coils and the compressors, specifications could be written calling for the maximum tonnage at a 75 F wet bulb, another lower tonnage at 70 F and also the capacity at 65 F; these varying capacities could be stated in the contract and the test conducted down to a wet bulb of 65 F.

With the specifications and contract written in this form the engineer would have a much greater latitude in testing the equipment under different wet bulb temperature conditions and considerable trouble and delay avoided. I am inclined to favor, however, a simple curve of performance and urge the desirability of furnishing this information.

I would be pleased to hear from anyone who has given this problem consideration and can offer a practical solution.

*Director of Research and Education, Refrigeration and Air Conditioning Institute. Member of Board of Consulting and Contributing Editors.

What's the E. D. R. of Indirect Heating Surface?

By William S. Downs*

In using unit figures in the control of steam consumption for heating buildings, it is essential that the equivalent direct radiation of the building be computed correctly. . . . . A method of doing this is given by Mr. Downs, who became interested in the matter in connection with the heating of a large building equipped with both direct and indirect radiation

THE distinction between heating surface area (H.S.A.) and equivalent direct radiation (E.D.R.) is not always fully appreciated by operating engineers. The following is intended as an explanation of this matter, and is based on a study made because the building with which I am concerned has both direct and indirect heating, and we have had some difficulty in arriving at a method of computing unit steam consumption for heating. It is believed that the figures given will serve to clarify the distinction between the two types of radiation.

The average daily mean temperature for New York City from October 1, 1936 to March 31, 1937 was 42.3 F. It was necessary to heat air at this temperature as it was drawn through the heating coils of our ventilating system to 72 degrees. Over a period of 150 heating days the indirect system consumed just about half the total steam consumption, despite the fact that the total heating surface area of the indirect heating coils was 14,636 sq ft as compared to 61,015 sq ft of direct radiation. This discovery led me to investigate and the result of study of the A.S.H.V.E. *Guide* and other engineering manuals unearthed the conclusions set forth in this article.

Our indirect heating coils, at the last season temperature interval, gave off approximately 116,725 Btu per min per 203,000 cu ft of air, which is the rated capacity of our blowers during these months; this figure is obtained by multiplying the total cfm by the constant, 0.575, which is the number of Btu required to heat 1 cu ft of air from 42.3 to 72 F.[1] Converting to hours, 60 times 116,725 equals 7,003,400 Btu per hr. We operate the heating system about 10 hr a day, so 10 times 7,003,400 equals 70,034,000 Btu per day. For a 150 day heating season, the seasonal output totalled 10,504,900,000.

Assuming 965 Btu per lb of steam, dividing this figure into 10,504,900,000 gives 10,885,000 lb consumed by the indirect system. This is approximately 50 per cent of our total consumption for both direct and indirect systems, which was 21,790,000 lb.

According to the A.S.H.V.E. *Guide*, "The output of a radiator can be measured only by the heat it emits. The old standard of comparison used to be square feet

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Irving Trust Co. Building at One Wall St., New York City

*Assistant Engineer, Irving Trust Building.

[1] A table showing Btu required for heating air appears on p. 684 of this issue.

of *actual surface,* but since the advance in radiator design and proportions, the surface area alone is not a true index of output." The *Guide* states that equivalent direct radiation (E.D.R.), is "By definition, that amount of heating surface which will give off 240 Btu per hr. The *equivalent* square feet of heating surface may have no direct relation to the actual surface area."

When laying plans for the installation of heating systems in new office buildings, designing engineers know from long experience that after their job is completed, the total E.D.R. will be closely equivalent to 1 sq ft to each 100 cu ft of interior space. If a building is partially heated by the indirect method of air tempering, the total E.D.R. must be calculated from season to season in accordance with actual working conditions, if this figure is to be used in recording steam consumption data. The E.D.R. of air tempering stacks in a non-recirculating ventilation system depends on the temperature, velocity and volume of the incoming air. When the temperature interval and cfm air delivery values are known it is a simple matter to find the E.D.R.

To illustrate, it may be assumed that a fan is to deliver 30,000 cfm of air to an office space of 70 F. The outside temperature is 30 F, giving a 40 degree temperature interval. The Btu figure for heating 1 cu ft of air through this interval is 0.783. Converting to total Btu per min, 30,000 times 0.783 equals 23,490 Btu. Sixty times 23,490 equals 1,409,400 Btu per hr and the equivalent radiation value will be 1,409,400 divided by 240, or 5872 hypothetical sq ft E.D.R.

Actually, the H.S.A. of the tempering stack for this type of fan would be around 1300 sq ft. The Btu rate per sq ft, however, is 4½ times greater than the standard 240. If an office building were equipped with a number of fans, then, the total E.D.R. of the indirect system might be 4½ times greater than the actual H.S.A.

To illustrate further, let us suppose that the outside temperature drops to zero but the delivery air requirements of the same fan have not been changed. We now have a 70 F temperature interval and the Btu required per cubic foot of air is increased to 1.459. Following through with the same method of calculation it will be found that the E.D.R. has almost doubled, and is about 8 times the actual H.S.A. of the heaters.

Recently, in discussing the merits of the heating system in a large office building, the operating engineer produced a chart which purported to be a breakdown of operating results over a period of five years. His figures showed a notable increased efficiency with a yearly decrease in pounds of steam consumed per degree day but his consumption rate per square foot of radiation was way out of proportion to the rate per cubic foot of building space. The building was credited with 76,000 sq ft E.D.R. and around 9½ million cube. A check of the figures showed the obvious discrepancy in E.D.R. was due to the erroneous method of rating both direct and indirect heating surface on the same basis. No allowance was made for the greater Btu output of the air tempering stacks.

Manufacturers have developed the construction of air tempering stacks until it is now possible to obtain maximum E.D.R. with a minimum actual area of heating surface. There are fin type coils and cast iron heaters which conform to the theory that air is more thoroughly heated when forced through a maze of irregular passages. Hundreds of fins or cored projections serve to restrict and break up the air. The result of this breaking up process might be likened to the action of a spray plate. It is, perhaps, difficult to visualize air being sprayed from the heating surfaces of the heater, yet this is very nearly the case. The heating stacks are sometimes arranged in staggered rows to enhance the effect.

A good method of setting up a comparative figure of steam consumptions (which could be termed "Normal Pounds Consumed per 1000 Sq Ft of E.D.R. per Degree Day") would be first to establish the average rate of Btu exchange of air tempering stacks during a heating season. It will be found that though this value may range from 2 to 7 times greater than normal, nevertheless, an average of from 3 to 4 is a safe estimate. Assume, then, a building of 10 million cu ft volume equipped with 60,000 sq ft of direct and 15,000 indirect heating surface. There is obviously a deficiency of at least 25,000 sq ft E.D.R. if the theory that there should be 1 sq ft of radiation to each 100 cu ft of building volume is substantial. But we have already determined that there is no basis for assuming that the H.S.A. and E.D.R. of indirect heating stacks are relative values.

We can take the H.S.A. multiply it by 3 and be reasonably certain that we have a good average, so 15,000 times 3 equals 45,000 indirect E.D.R. The H.S.A. and E.D.R. values of the direct heaters are practically equivalent and adding 60,000 to 45,000 we now have a total of 105,000 sq ft E.D.R. This figure is slightly over the rule of thumb ratio of 100 to 1, giving an advantage which is not by any means extreme; there is nothing hypothetical about a little extra radiation when zero weather sets in, and this applies particularly to the air tempering stacks.

Most office buildings operate at full load on an average of 14 hr a day during the heating months. Full heat may not be turned on during these hours but if the heavy morning load and partial night heating are considered, the 14 hr day will serve as a fairly accurate figure.

We have already seen that 1 sq ft E.D.R. will give off 240 Btu, so 105,000 times 240 equals 25,200,000 Btu per hr. Dividing this figure by 965 Btu per lb of steam equals 26,114 lb consumed per hr of operation and converting to days 26,114 times 14 equals 365,596 lb. Assuming zero temperature and a 65 F degree day base, 365,596 divided by 65 equals 5624 lb consumed per degree day for this building. Divide 5624 by 105,000 sq ft and we have 53.5 lb of steam consumed per 1000 sq ft E.D.R. per degree day.

The engineer who uses this method will find that he will have to be on the alert to keep within his estimate. It can be done, however, if the system is tight and maintenance of traps, valves, pumps, and expansion joints is up to par. It is a simple matter to substitute figures from another type of building and operating staffs can be certain that their systems are efficient if the actual consumption rate is less than an estimate arrived at in this manner.

New Data for Refrigeration

Piping Design

Methyl Chloride Suction Piping

By R. C. Doremus*

PIPING of liquid methyl chloride (CH_3Cl) was discussed last month[1] and it was pointed out how important it is to install piping of ample size to pass a sufficient amount of liquid for the capacity of the refrigerating system. This is primarily a question of keeping the velocity of the liquid flow in the distribution piping within practical limits and avoiding bottlenecks. Curves were presented showing pressure drops of liquid methyl chloride passing through thermal expansion valves and solenoid liquid shut-off valves of various size orifices to enable the designer to calculate total line pressure drops and thus assist in proper design.

It is even more essential that the suction piping be properly designed and installed if the major equipment such as compressor and evaporators, which are connected by this piping, are to perform to their rated capacity. In the average plant, one does not often find abnormal liquid pressure drops, for the lines are usually chosen of suitable size and the factors affecting the liquid velocity—such as change in temperature, gas and oil—do not change this velocity enough to cause any noticeable result in operating conditions. However, due to the large variation in the specific volume of the vapor and, consequently, the variation of some 500 per cent in velocity of the vapor in the suction pipe line, a bad error can easily be made in the choice of suction line pipe size, which will seriously incapacitate the whole system.

Methyl Chloride Vapor Characteristics

The saturated vapor of methyl chloride may be considered as being of average or medium weight and density as it lies between the light weight of ammonia and the heavy weight of "Freon-12." Both the molecular weight and the specific gravity of the saturated vapor of methyl chloride are between the corresponding values of ammonia and "Freon-12." It is approximately twice as heavy as ammonia and one-third as heavy as "Freon-12." However, the proper size of suction lines to be used for handling this vapor cannot be approximated in this manner but should be planned on the basis of gas velocities and corresponding pressure drops, for it is the drop in pressure which so vitally affects the suction or back pressure and hence the capacity of the compressor, which is the heart of the refrigerating system.

As with "Freon-12," it is considered good practice in designing methyl chloride suction piping for the total pressure drop from the most distant evaporator to the compressor not to exceed 2 to 3 lb per sq in., although there are some instances of installations made with as much as 8 to 10 lb drop. These are seldom encountered but are examples which are to be avoided. In some cases, the pressure drop of the vapor in passing from the suction pipe main through the suction service valve into the compressor crankcase may be one-half to 1 lb and such instances are usually met only on the machines of very small capacity. In the case of larger compressors, this suction valve drop will not be over one-third of these values.

If the designer or contractor does not know the pressure drop in the suction pipe line from evaporator to compressor and simply guesses at the proper size pipe to be used, he is more apt to be wrong than right. If, perchance, suction piping of too small size is installed, the evaporator and compressor capacities will both suffer, resulting in expense to rectify the troubles, in forfeits or unfulfilled guarantees, all of which are detrimental to the operation of the system. On the other hand, the guess-work may call for too large a suction line pipe size. Here, the contractor may lose the contract because of exorbitant cost of the suction piping and insulation or, if he should succeed in landing the contract notwithstanding, he will make a smaller profit than might have been possible with better engineering foresight.

Obviously, the optimum condition is a suction line of proper size, as short and direct as possible with a minimum of valves, fittings and offsets—which are restrictions and impede the flow of gas. The total pressure drop in the suction main piping will be the total of the individual losses of these items and a working knowledge of their respective values is essential. Table 1 is a friction table for valves and fittings in methyl chloride suction lines equated to equivalent length of straight pipe of the same size. None of the values in this table is guaranteed to be 100 per cent accurate, for some interpolations are included, but the table will assist in making computations.

Pressure Drops with Methyl Chloride Vapor

Figs. 1 and 2 show pressure drops of methyl chloride vapor for various tonnage capacities through 100 lineal feet of copper pipe of different sizes for saturated gas at 0 F; Figs. 3 and 4 show these drops for saturated suction gas at 41 F. These may be used with Table 1 to obtain the total pressure drops for the whole suction line.

For example, assume we have a layout for a rather large market in which there is a load of 40 tons of refrigeration, suction temperature of 0 F, and the suction

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[1] HEATING, PIPING AND AIR CONDITIONING, October, 1937, pp. 603-607.

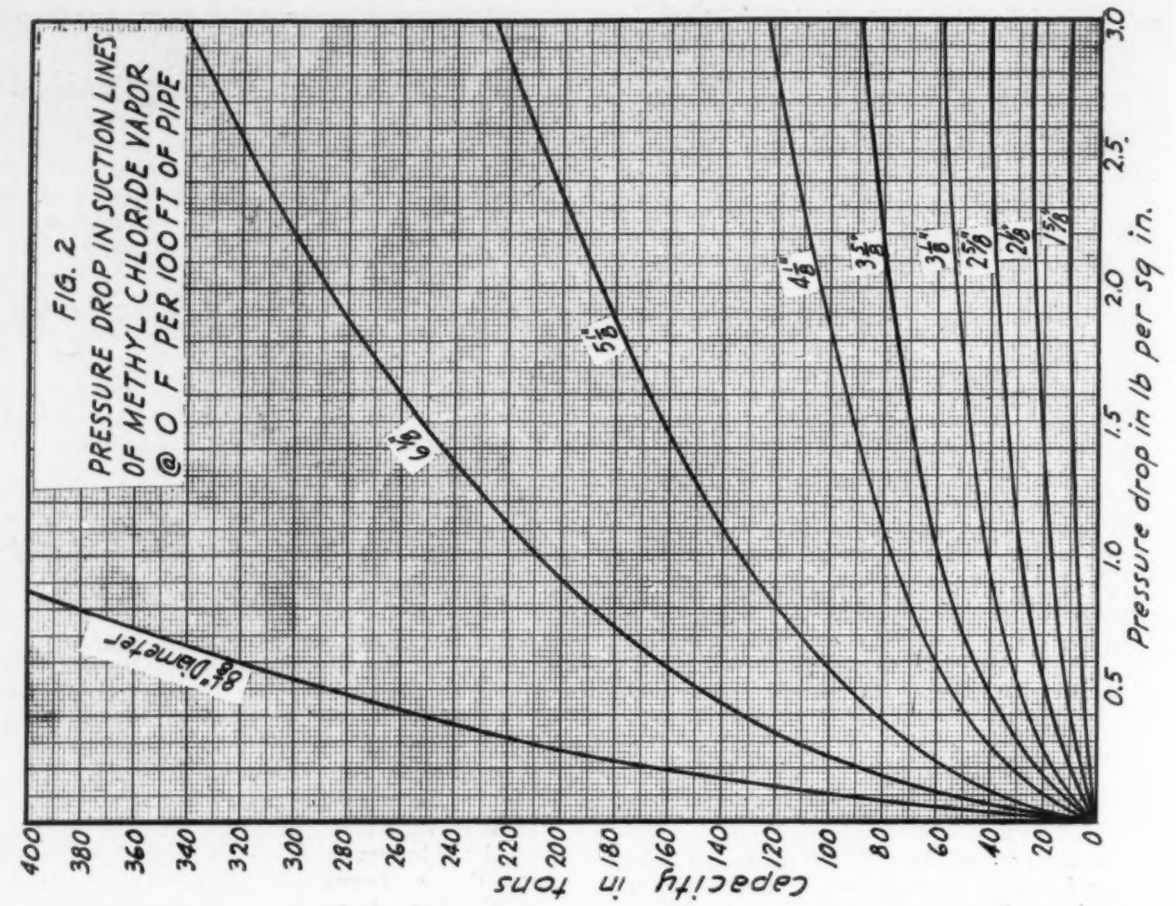


FIG. 2
PRESSURE DROP IN SUCTION LINES OF METHYL CHLORIDE VAPOR @ 0 F PER 100 FT OF PIPE
8" Diameter
6"
5⅛"
4⅛"
3⅝"
3⅛"
2⅝"
2⅛"
1⅝"
Capacity in tons
Pressure drop in lb per sq in.

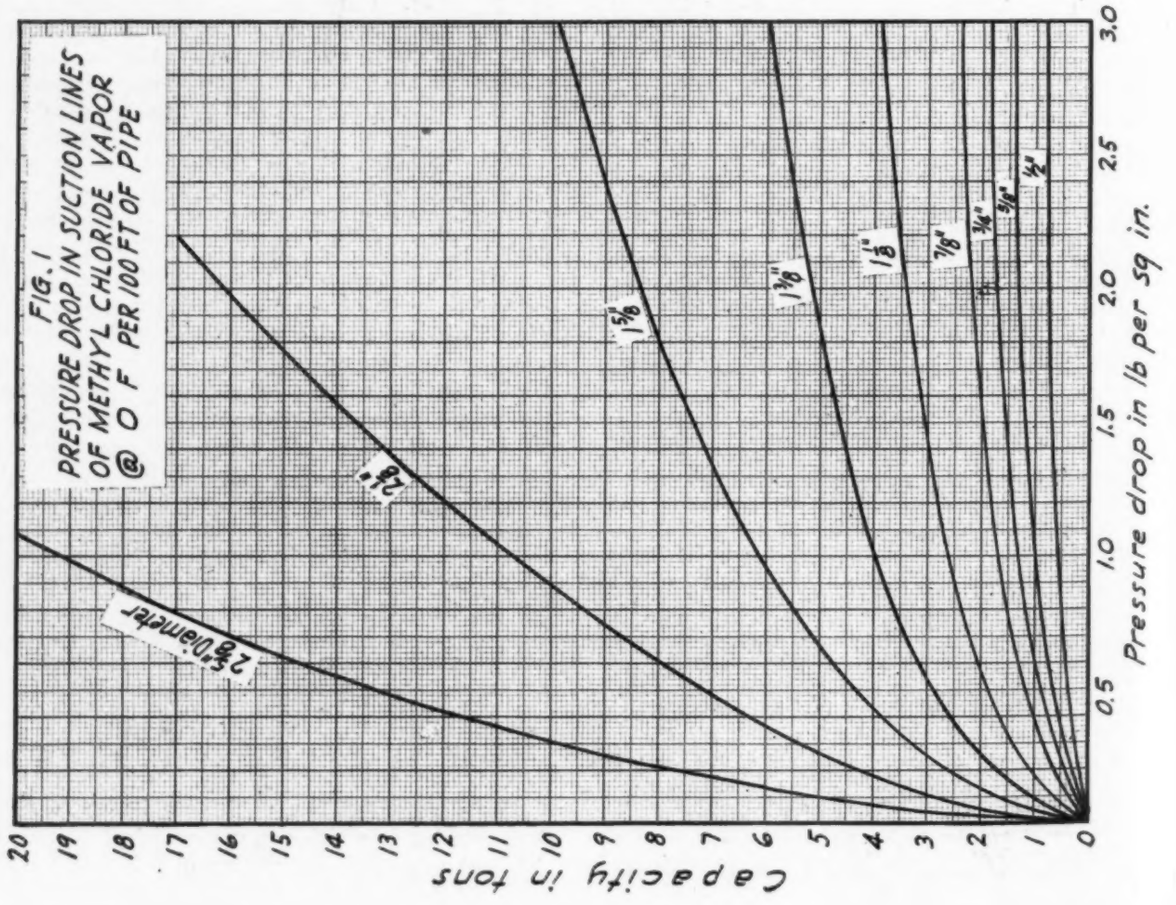


FIG. 1
PRESSURE DROP IN SUCTION LINES OF METHYL CHLORIDE VAPOR @ 0 F PER 100 FT OF PIPE
2⅝" Diameter
2⅛"
1⅝"
1⅜"
1⅛"
⅞"
¾"
⅝"
4"
Capacity in tons
Pressure drop in lb per sq in.

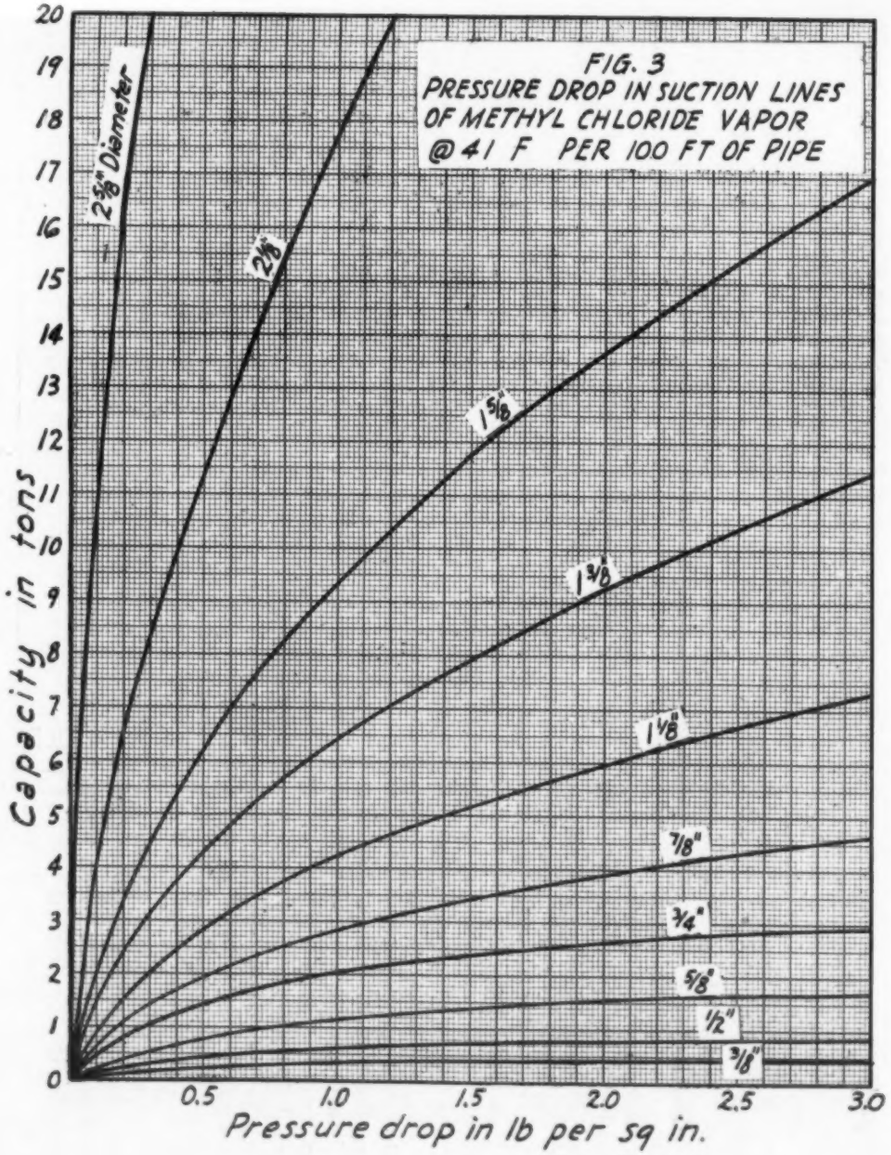


FIG. 3
PRESSURE DROP IN SUCTION LINES OF METHYL CHLORIDE VAPOR @ 41 F PER 100 FT OF PIPE

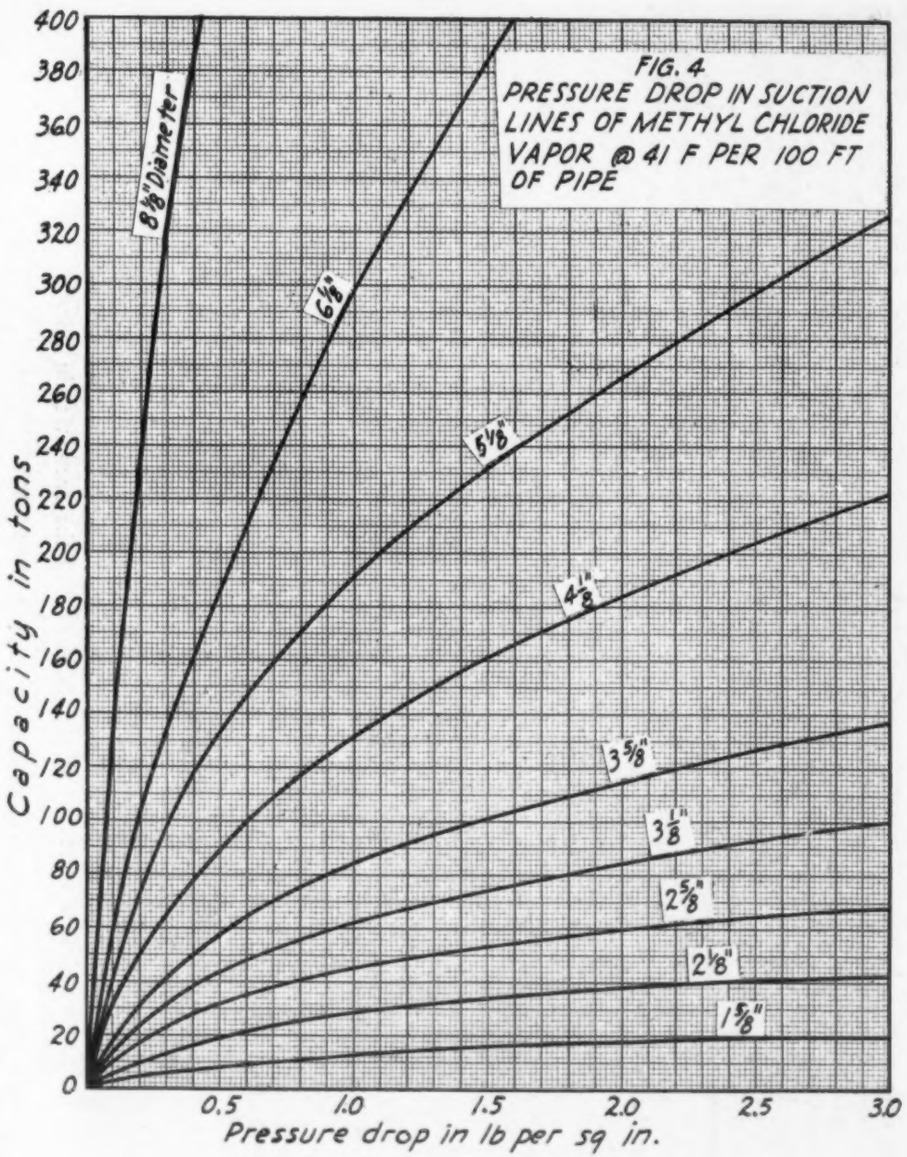


FIG. 4
PRESSURE DROP IN SUCTION LINES OF METHYL CHLORIDE VAPOR @ 41 F PER 100 FT OF PIPE

Basic data on the design and installation of piping for industrial and commercial refrigeration work and air conditioning are presented. As a refrigeration engineer, Mr. Doremus has had the opportunity to observe jobs which have been poorly designed, has concluded that lack of information is the cause. He therefore makes his data available in this form

pipe line is 225 ft long and includes eight elbows, 10 tees and two valves. If we check this for a 3⅛ in. O.D. copper suction line, the computations will be as follows:

8 elbows @ 8 ft..... 64 ft
10 tees @ 12 ft.....120 ft
2 valves @ 15 ft..... 30 ft
225 ft of pipe.....225 ft

Equivalent total .....439 ft

(439 ÷ 100) × 0.93 (from Fig. 2) = 4.08 lb drop. This is too much for good design.

If we check this condition for a 3⅝ in. O.D. copper suction line, the computations will be as follows:

8 elbows @ 10 ft..... 80 ft
10 tees @ 15 ft.....150 ft
2 valves @ 18 ft..... 36 ft
225 ft of pipe.....225 ft

Equivalent total .....491 ft

(491 ÷ 100) × 0.48 = 2.35 lb drop, which is satisfactory.

However, suppose we had this same load of 40 tons of refrigeration in a different layout in which a 3⅛ in. suction line was only 100 ft long and contained four elbows, four tees and two valves:

4 elbows @ 8 ft..... 32 ft
4 tees @ 12 ft..... 48 ft
2 valves @ 15 ft..... 30 ft
100 ft of pipe.....100 ft

Equivalent total .....210 ft

(210 ÷ 100) × 0.93 = 1.95 lb drop, which is also satisfactory.

It is obvious that the same size suction piping cannot be used for these two cases, although the tonnage capacity in each is the same, for the layouts are quite different. For this reason, no one can safely dictate what size suction line should be used for a given tonnage job unless he uses a wide margin of safety, which, as shown above, is dangerous to cost. For the same reason, no short rule-of-thumb can be given to suit all cases. Each must be checked in view of the local job conditions and the layout of equipment.

Tons Capacity of Suction Piping

The capacity in tons of refrigeration that may safely be carried in any suction pipe line is determined by maximum pressure drop and this resolves itself into a question of gas velocity. Table 2 gives gas velocities for methyl chloride suction vapor in feet per minute per ton in various sizes of copper pipe for saturated temperatures from —40 F to +41 F, which will cover most installations.

This table shows the variation in gas velocity at different suction pressures and temperatures. This variation is rather widespread and in any one pipe size is caused principally by the difference in the specific volume of the vapor at different suction pressures; this also determines the actual displacement required of the compressor to produce a ton of refrigeration under given conditions. This table also gives the maximum velocity of gas that should be permitted in each pipe size under ordinary conditions, based on the author's experience, from which a designer may easily pick a suitable pipe size for any installation.

For example, if we have an installation with a 20 ton load and the work is to be done with an evaporator temperature of +10 F, we can readily see from the table that we should use a 3⅛ in. O.D. copper suction line:

20 × 120 = 2400 fpm. This velocity is suitable for a 3⅛ in. suction line.

However, suppose we had this same tonnage in another job and the work is to be done at a lower temperature; we will see that the same size suction line should not be used. Assume 20 tons at —10 F:

20 × 185 = 3700 fpm. This velocity is too high for a 3⅛ in. suction line without causing an abnormally large suction pressure drop between the evaporator and compressor.

If we check this for a larger (3⅝ in.) pipe line:

20 × 136 = 2720 fpm. This velocity is satisfactory for a 3⅝ in. suction line.

Suppose we have two evaporators, one of 3 tons capacity and the other of 5 tons and the work is to be done at 15 F. We want to size the branch suction lines and the suction main line.

3 × 569 = 1707 fpm. This is too high a velocity for 1⅜ in. where 1400 fpm is maximum.

3 × 402 = 1206 fpm. This velocity is satisfactory for a 1⅝ in. pipe where 1600 fpm is maximum.

5 × 402 = 2010 fpm. This velocity is too high for 1⅝ in. pipe where 1600 fpm is maximum.

5 × 231 = 1155 fpm. This velocity is satisfactory for 2⅛ in. pipe where 1800 fpm is maximum.

Now, when we join these two lines in one suction main, of what size should the main be? If we simply equalize the pipe sizes by totalling the areas, we would use a 2⅝ in. main, as follows:

Internal area of 1⅝ in. pipe = 1.78 sq in.
Internal area of 2⅛ in. pipe = 3.10 sq in.
Total 4.88 sq in.

Internal area of 2⅝ in. pipe is 4.78 sq in., and this size would probably be used.

However, by checking this load in Table 2, we find that a 2⅛ in. suction main may be used:

8 × 231 = 1848 fpm. This velocity is satisfactory for a 2⅛ in. main where 1800 fpm is maximum.

If we had not checked this with Table 2 but had

Table 1—Pressure Drop of Methyl Chloride Vapor Due to Valves and Fittings in Equivalent Length in Feet of Straight Pipe of Same Size

Copper Pipe Size In. O. D.	⅜	½	⅝	¾	⅞	1⅛	1⅜	1⅝	1⅞	2⅛	2⅝	3⅛	3⅝	4⅛	5⅛	6⅛	8⅛	10⅛	12⅛
Elbow	2	3	3	4	5	6	7	8	10	12	16	20	26	32	40
Tee	3	4	4	5	7	8	10	12	15	18	24	30	40	50	60
Valve	3	4	5	6	8	10	12	15	18	20	30	40	55	70	85

Table 2—Velocity Chart for Methyl Chloride Suction Vapor at Various Suction Temperatures for Copper Piping of Different Diameters, in Feet Per Minute Per Ton of Refrigeration

Suct. Temp. F	Corr. Pressure Lb/Sq In.		Sp. Vol. of Sat. Vapor Cu Ft/Lb	Total Heat of Vapor Btu/Lb	Heat of Liquid @94F Btu/Lb	Refrig. Effect Btu/Lb	Weight Lb/Min/Ton	Actual Displacement Cu In./Min/Ton	Copper Pipe Sizes, In. O. D.															
	Abs.	Ga.							⅜	½	⅝	⅞	1⅛	1⅜	1⅝	2⅛	2⅝	3⅛	3⅝	4⅛	5⅛	6⅛	8⅛	10⅛	12⅛
—40	7.0	15.4*	12.57	183.5	48.5	135.0	1.481	32.200	18,390	11,520	7,535	5,535	3,240	2,132	1,508	866	562	394	291	223	144	100	55.9	38.3	26.6
—35	8.0	13.4*	11.00	184.7	48.5	136.2	1.469	27,900	15,920	10,000	6,800	4,800	2,810	1,850	1,307	750	487	341	262	193	125	86.5	48.5	33.2	23.0
—30	9.0	11.4*	9.70	186.0	48.5	137.5	1.455	24,400	13,930	8,730	5,960	4,200	2,456	1,618	1,153	656	426	299	220	169	109	76.2	42.4	29.0	20.2
—25	10.2	8.9*	8.60	187.5	48.5	139.0	1.440	21,400	12,220	7,650	5,680	3,680	2,155	1,418	1,008	575	374	262	193	148	95.5	66.5	37.2	25.5	17.7
—20	11.5	6.4*	7.80	189.0	48.5	140.5	1.424	19,200	10,960	6,860	5,300	3,300	1,933	1,272	900	516	335	235	173	133	85.5	59.7	33.4	22.8	15.8
—15	13.0	3.3*	7.00	190.2	48.5	141.7	1.412	17,080	9,750	6,100	4,940	2,940	1,718	1,133	803	459	298	209	154	118	76.0	53.1	29.6	20.3	14.1
—10	14.5	0.3*	6.25	191.5	48.5	143.0	1.400	15,150	8,620	5,400	4,590	2,590	1,520	1,000	708	406	264	185	136	105	67.3	47.0	26.2	17.9	12.5
—5	16.5	1.8	5.60	192.7	48.5	144.2	1.387	13,450	7,650	4,790	2,305	1,350	888	628	360	234	164	121	93.1	59.7	41.7	23.3	15.9	11.1	
0	18.5	3.8	5.05	194.0	48.5	145.5	1.374	11,990	6,840	4,280	2,060	1,206	795	560	322	209	146	108	83.3	53.3	37.2	20.8	14.3	9.9	
5	20.8	6.1	4.53	195.2	48.5	146.7	1.363	10,700	6,110	3,825	1,840	1,077	709	504	287	187	131	96.7	74.0	47.7	33.2	18.6	13.2	9.3	
10	23.3	8.6	4.15	196.5	48.5	148.0	1.350	9,660	5,540	3,470	1,668	977	644	455	251	169	120	87.6	67.3	43.3	30.2	16.9	11.8	8.0	
15	25.7	11.0	3.70	197.7	48.5	149.2	1.340	8,560	4,900	3,070	1,476	863	569	402	231	150	105	77.5	59.5	38.3	26.7	14.9	10.2	7.1	
20	28.3	13.6	3.25	199.0	48.5	150.5	1.329	7,490	4,250	2,660	1,282	750	494	349	200	130	91.2	67.4	51.6	33.2	23.2	13.0	8.9	6.2	
25	31.5	16.8	2.90	200.0	48.5	151.5	1.320	6,600	3,780	2,370	1,140	666	439	310	178	115	81.4	59.8	46.0	29.5	20.6	11.5	7.9	5.5	
30	35.0	20.3	2.71	201.2	48.5	152.7	1.310	6,130	3,500	2,190	1,055	618	407	286	165	107	75.3	55.3	42.6	27.3	19.1	10.7	7.3	5.0	
35	38.9	24.2	2.44	202.5	48.5	154.0	1.298	5,450	3,130	1,960	960	552	363	256	146	95.5	67.2	49.3	38.0	24.4	17.0	9.5	6.5	4.5	
40	42.8	28.1	2.25	203.7	48.5	155.2	1.289	5,020	2,880	1,798	870	506	333	235	135	87.6	61.4	45.2	34.8	22.4	15.6	8.7	6.0	4.1	
41	43.6	28.9	2.20	203.9	48.5	155.4	1.287	4,920	2,795	1,750	855	492	324	229	131	85.3	59.8	44.1	33.9	21.8	15.2	8.5	5.8	4.0	
Maximum Recommended Velocity, fpm									500	800	1,100	1,300	1,400	1,600	1,800	2,100	2,400	2,800	3,000	3,400	3,800	4,400	5,200	6,000	

*All pressures marked (*) are vacuum expressed in inches of mercury.

chosen to install a 2⅝ in. main, arrived at by equalizing the pipe sizes:

$8 \times 150 = 1200$ fpm.

This is not only an extremely low velocity for this size of pipe, but costs more to install and also will cause an increased pressure drop due to the rapid step-up and step-down in gas velocity, which should be avoided.

The value of such a table of velocities is clearly evident but it should be emphasized that it is intended for general use in order to save time in making approximations and that the designer should always check the problem carefully with the pressure drop charts in order to determine whether the size chosen from this table will give a suitable pressure drop for his particular problem.

Foolish Economy to Skimp on Piping

Using too small a suction pipe size in an endeavor to save money is foolish economy. The consequent high gas velocity causes such a large pressure drop that the plant capacity is decreased by compelling the compressor to operate at a much lower suction pressure than is otherwise necessary.

For example, suppose that the evaporators are planned to operate at a gage pressure of 13.6 lb at a temperature of 20 F and it has been assumed that the suction pressure drop will be normal, or around 2 lb. Accordingly, the compressor would operate at a pressure of 11.6 lb, at which pressure it has, say, a capacity of 77,000 Btu per hr. Instead of the assumed pressure drop of 2 lb, the pipe line is so small that the pressure drop is 8 lb. Then, 13.6 — 8.0 = 5.6 lb.

The compressor capacity at this lower suction pressure may be only 60,000 Btu per hr which means that the plant is shy 17,000 Btu per hr. If it was planned very close to peak requirements, or if a guarantee was given on capacity that has not been met, the capacity will have to be bolstered up.

As long as this small suction line is installed, the only way to get more capacity is to change the compressor to one of a larger size in order to get more displacement, or to speed up the compressor by a change in the motor pulley, drive belts, motor or all three. Any of these alternatives is expensive. Even though the speeded up compressor may be handling the load temporarily, the power bills and cost of lubrication, worn parts and maintenance are too high, causing high service costs. Obviously, the only way properly to correct the difficulty is to leave the compressor and drive unchanged, remove the small suction pipe line, and install the correct size so that the load may be handled with minimum power and maintenance bills.

The suction main piping is the poorest place in the whole system to endeavor to skimp on size to save money, for the saving is small and the consequent increased cost is extremely high. Any plant will pay dividends on proper size suction piping.

EXAMPLE—20 Ton Load @ + 10 F.
20 x 160 = 3350 fpm, which is too high velocity for a 2⅝ in. pipe.
20 x 120 = 2400 fpm, which is satisfactory velocity for a 3⅛ in. pipe.

Don't Forget Air Conditioning Maintenance

By C. T. Baker*

REGULAR inspection or examination of air conditioning plants by a competent person is important if efficiency of the system is to be maintained and performance kept satisfactory. This is particularly essential with the smaller installations that are not under the direct supervision of an expert engineering force, and for which there is no routine maintenance schedule.

Frequently, operating difficulties will come up, but the solution of them will be found to be comparatively simple. A recent experience of the writer's is an example.

An air conditioning plant in a department store was not producing the desired results and the general manager was inclined to be rather caustic about air conditioning in general, since this was his second attempt to provide year 'round comfort for his customers. The plant was the product of changes made in a system installed some years ago and which had not, in his opinion, performed as it should.

The revamped system consisted of three 21 ton compressors, three 20 ton evaporators and a motor driven fan with a capacity of approximately 31,700 cfm under the conditions at which it operated. The evaporators were operated at a pressure corresponding to a temperature of 40 F. The plenum chamber, evaporators, winter heating coil and fan were enclosed in a wooden structure erected on the second floor, the walls and ceiling of which were made of ⅝ in. tongue and grooved lumber supported in the conventional manner by studding and joists.

Loss of Capacity Due to Infiltration

Due partly to lack of care in building, but mostly to subsequent settling and distortion caused by vibration, the walls and ceiling disclosed innumerable cracks and openings through which warm air was being drawn into the structure, when tested with a lighted candle. At times this warm air contained considerable moisture resulting from the changing atmospheric conditions on the second floor. Needless to say, this imposed a heavy load on the air conditioning plant. It required nearly an entire day for two men effectively and permanently to close all the openings.

Strange as it may appear, openings in the walls which had been made for the suction and liquid lines, electric conduits, etc., had not been sealed after the pipe work and electric work were finished, with the result that large quantities of warm air were entering at each of these several openings, one of which was approximately an inch larger in diameter than the outside diameter of the tubing that passed through it.

In the original system, a spray washer had been employed for cooling and washing the air; this had required a 3 in. water supply pipe and a 4 in. return. When the change to dry type evaporators, placed in the spray chamber, was made these two pipe lines had been disconnected but not removed.

With one end of each of these large pipes in the hot basement and the other end in the evaporator enclosure, it does not call for much imagination to understand that a continuous stream of warm, moisture laden air was being drawn into the enclosure, which of course added to the cooling plant load.

An examination of the evaporator section of the enclosure disclosed excessive waste and loss in cooling capacity due to the large volume of air that was short circuiting around the evaporator, partly the result of poor workmanship and partly due to leaky bypass dampers that were provided primarily for use when the heating system was in operation.

The correcting of this condition also produced a decided improvement in cooling effect.

Duct Not Insulated

Considerable loss of refrigeration occurred where the suction and discharge connections were made to the fan. On the suction side warm air was being pulled in, while on the discharge side cold air was being wasted, through improperly made joints.

Some time after the original installation was made, a trap door or manhole had been installed in a discharge duct. To do this it was necessary to remove considerable of the cork lagging used for insulating this duct. This insulation had never been replaced and as a consequence a great deal of heat was being taken up through this exposed surface since the surrounding air temperature was normally 94 F. With an inside air temperature of 58 F it is evident that considerable heat would pass through the several square feet of exposed surface. In addition, an opening had been cut in the top and bottom of the discharge duct to permit the passing of a steel tie rod, one end of which was connected to the roof I beams and the other to the floor below. Since these openings were larger than the tie rod, cold air was being discharged

*Consulting Engineer.

through them, which of course represented a loss in net cooling capacity.

A check up of the charge of refrigerant disclosed an insufficient quantity in the system. This was corrected by the addition of sufficient refrigerant to bring the charge up to the system requirements.

An examination of the air filters showed that they were very dirty and as a consequence considerable air pressure drop resulted. A number of new sections of filters were installed which resulted immediately in an improvement in the volume of air being handled.

After correcting these various conditions, a decided improvement in plant performance was noted; in fact much of the time it is possible to carry the load with two of the installed compressors rather than running all three.

Since observing this condition, and particularly the losses due to infiltration of warm air, the writer has had occasion to examine other systems of this general design and in each case it was noted that considerable loss in net cooling effect results from improperly made joints in duct work and metal enclosures. Many installers apparently have the idea that sheet metal work held together by rivets placed on 6 to 8 in. centers will be tight. This however is not the case and if duct and sheet metal work is erected in this manner, loss in capacity and performance may be expected.

Another Case

Another store air conditioning installation that the writer recently investigated was one of approximately 7 tons refrigerating capacity with the compressor and condenser situated on the third floor and the evaporating element on the second floor. The return and outside air supply were combined in the usual plenum chamber arrangement. The fan was of sufficient capacity to maintain a slight static pressure in the store. There had been considerable complaint concerning offensive odors at certain times, and one of the purposes of the inspection was to find the cause of this.

The outside air duct extended from the plenum chamber to the outside of the building, terminating in an alley. It so happened that the occupants of the adjacent building used the alley freely for the storage of garbage cans which were emptied about every other day. These garbage cans had no covers, which made matters worse. It was not difficult to discover the source of the offensive odors.

It was the practice to burn refuse, paper, etc., in the alley two or three times a week and since the fire was built close to the outside air inlet duct, a great deal of smoke was drawn into the system and discharged into the store while particles of partially burned paper and other light debris were deposited in the air filters. Needless to say, arrangements were made to change the source of the outside air supply.

Electric Heating System Defrosts Store Windows

By W. F. Mainguy*

I HAVE read with interest the short article on ventilating and heating of store windows in the August HEATING, PIPING AND AIR CONDITIONING. I note that you would like to have information from others who have had experience with this problem, and as we have done a certain amount of work on it in the past couple of years, I am submitting the following comments:

In Quebec, the problem of defrosting store windows, particularly those where humidity is high as, for example, grocers' and butchers' shops, is quite a serious one. Outside temperatures of 20 to 30 F below zero are reached, and sub-zero weather is quite common. Numerous attempts at solving the problem by means of double glass windows, circulating fans, gas heaters, etc., have been made, but without a great deal of success.

The problem was brought to us by some of our customers, particularly grocers, who asked if some means of applying electrical heat could keep their windows clear.

Our first experiments consisted of installing an electric tubular heater across the bottom of the window, the heater consisting of a 2 in. diameter steel tube in which was mounted a spiral nichrome element insulated from the tube by suitable mica discs and porcelain spacers. The loading was 70 watts per lineal foot. This scheme worked only so long as outside temperatures did not drop below, say, 15 F, or in stores where the humidity was relatively low. Incidentally, most store windows with which we have had to deal are open to the store, which naturally makes the problem a very serious one.

Our next attempt was with unit heaters of approximately 1,000 watt capacity, of the type in which a small fan forces air over a series of electric heating elements. This also worked only so long as outside temperatures were not too low. In the case of very low temperatures, the area defrosted was only approximately 3 to 4 ft in diameter per heating unit.

The latest attempts have been with a perforated duct placed along the base of the window through which is blown air which has been electrically heated. This is the method referred to by Mr. Brunel in the August issue, except that electric heating is used. Various forms of this have been tried, and it is the most satisfactory method which we have tested, although the final design has not yet been decided. As a rough guide, it appears that for this climate at least 100 watts per lineal foot of window will be required wherever there are high humidity conditions. I am unable, at the present time, to give any definite figures as to the amount of air or capacity of fan which should be employed.

An important factor in this problem is to determine whether the system to be adopted will be required only to keep a window from frosting up, *i.e.*, that it will be running continuously, or whether it will be expected to defrost a window. The latter condition is, naturally, much more severe, but from our experience it would seem that the necessary capacity to defrost a heavily frosted window would be required in many cases.

So far, our concern has been only with the winter aspect of this problem.

*Power Sales Engineer, The Shawinigan Water & Power Co.

Office Building Cleans Air Electrically

General view of the Field Building installation

An installation of a recently developed method for cleaning air by means of electrostatic precipitation is described, and information on the principle of operation, power requirements, and industrial and commercial applications is given. . . . The method consists, briefly, of first passing air through an ionizing chamber, where the dust particles take on an electrical charge, and then through a chamber in which are charged collector plates, to which the dust particles are attracted—much as a magnet attracts iron

ONE of Chicago's leading office structures, the Field Building, is cleaning air by a new electrical precipitation method with equipment which was placed in operation in September. Representing the first large commercial installation for cleaning ventilating air by this means, the Field job is designed to clean 272,000 cfm of air at an efficiency of 93 per cent (by blackness test). Individual capacities of the precipitation units range from 2250 to 30,000 cfm, and in this installation collector cells made of aluminum are used because the air passing through them previously goes through washers for temperature and humidity control and is practically saturated.

Cleaning air for four floors and the lower arcade of the building, it is estimated that in a year's time the units will have collected approximately 600 bushels of impurities, 90 per cent of which will consist of particles 1/100 the diameter of human hair. By weight, the collection will consist of one-third ash; another third fixed carbon, soot lampblack and other derivatives; and the remaining third volatile matter such as oils and greases. Sulphur, bacteria, pollen in season, and other substances found in suspension in the atmosphere of any city are also deposited on the plates.

Principle of Operation

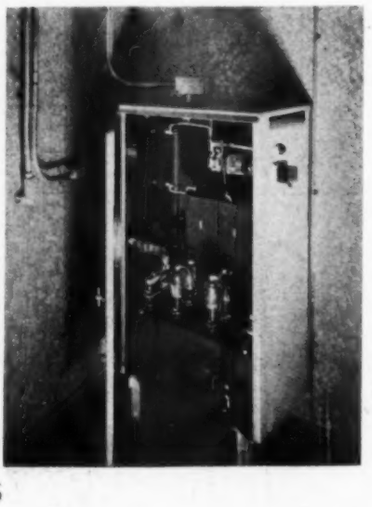
An electrical precipitation unit consists of three parts: (1) The ionizing unit, (2) The collector cell, (3) The power pack.

The ionizing unit is essentially a fine wire centrally located between two grounded rods with a potential of 12,000 volts d-c applied between the wire and the tubes. In this method the ionizing wire is a positive potential, for it has been found by research that the quantity of ozone produced with the arrangement of polarity is about 1/10 of that with negative ionization. The air to be cleaned is passed through the ionizer where the particles of dust accumulate a charge.[1]

After the particles have received their charge they are carried on into the collector cells which consist of a series of flat plates mounted in a case. In the cells used for air cleaning the plates are spaced $\frac{5}{16}$ of an inch between centers and in order to obtain a strong electrostatic field a potential of 5000 volts d-c is applied between adjacent plates. The spacing of plates must be accurately maintained and the plates themselves must have a high degree of flatness in order to have a uniform field throughout the structure. The construction of the cells is in the nature of precision work rather than an ordinary sheet metal assembly.

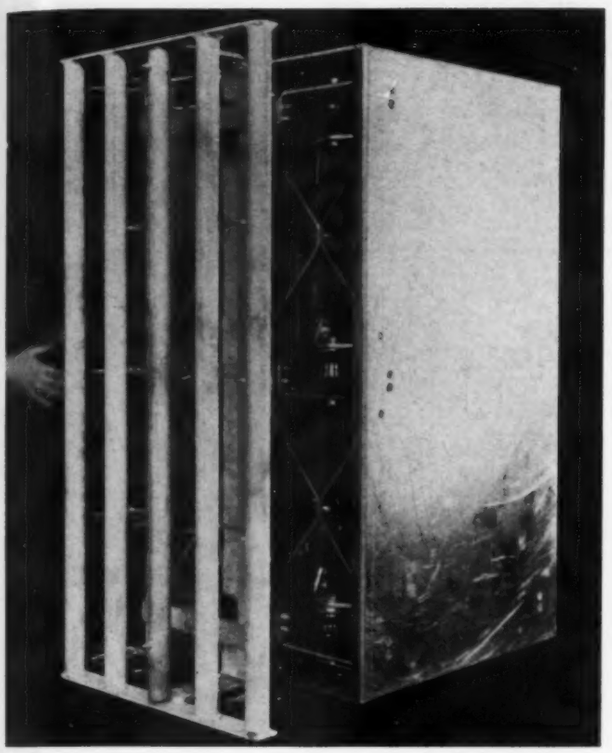
When the air carrying the charged particles enters the plate structure, the force of the strong electrostatic field draws the charged particles from the air much in the same manner as a magnet attracts a steel filing. When the dirt is deposited upon the collector plate it gives up its charge and is held by adhesion. Most atmospheric dust adheres to a dry electrode. However, in special cases it is sometimes necessary to coat the plates with oil or other material that will cause the dirt to adhere. If the air velocity is made sufficiently low to catch every particle, the cleaning efficiency would be 100 per cent. However, since all particles do not receive the same charge and due to the presence of eddies in the air and non-uniformities in the electrostatic field,

Close-up of one of the power packs



This article is based largely upon a paper presented by H. W. Tenney, Manager, New Products Engineering, Westinghouse Electric & Mfg. Co., at a meeting in Chicago, October 21. Illustrations courtesy Westinghouse.

[1]The theoretical and mathematical considerations involved in the charging of the dust particles are outlined in "A New Electrostatic Precipitator," by G. W. Penney, *Electrical Engineering*, January, 1937.



The ionizer and collector cell assembly. At the left are the tubes and wires of the ionizing chamber, and at the right, the collector cells where the ionized dust particles are removed from the air

at the air velocities used, the efficiencies run approximately around 93 to 95 per cent by blackness test.[2]

The voltage for the ionizing unit and for the collector cells is obtained from the power pack which is a combination of transformers, rectifiers and capacitors designed to be supplied from the ordinary 110 volts, 60 cycles, single phase. The power required for an electrostatic precipitation unit cleaning 3000 cfm of air is less than 100 watts and for a larger assembly of cells for cleaning 30,000 cfm, the power consumption is less than 500 watts. A typical reading on a 30,000 cfm unit at the Field Building for a 24 hr period showed 9.5 kwhr for the day period and 3.5 kwhr for the night.

As dirt accumulates on the collector cell plates it is necessary to clean these from time to time. For ordinary air cleaning one simple method has been to wash the cells down periodically, allowing the insulation to dry for 15 or 20 minutes prior to again applying the ionizing potentials. In industrial applications the method of cleaning required depends on the nature of the product recovered and whether or not it must be kept dry. Where the material is a dry powder which will be adversely affected by washing, the plate structures have been cleaned by rapping.

Has Industrial Uses

The first industrial installation of any magnitude was for the recovery of glaze in automatic glaze spraying machines at the Homer Laughlin china plant in Newell, West Va. Ten units were installed and each unit collects 800 lb of glaze varying in value from $0.06 to $2.00 per lb in a 40 hr week. Besides the recovery of the material the units release 300 sq ft of floor space at each of the spraying machines formerly occupied by a settling chamber which required 8 hr to clean compared with 30 minutes for the new units.

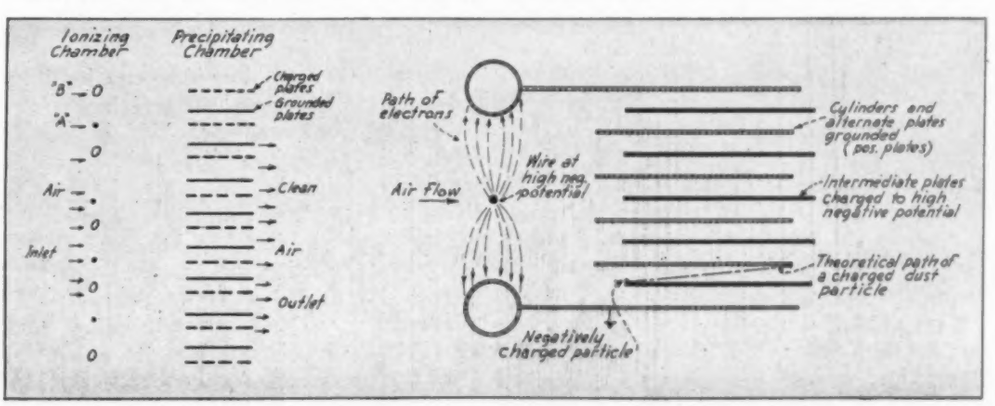
The units not only recover the glaze but it is automatically fed back into the spraying machines immediately instead of necessitating manual collection at intervals. When changing colors of glaze the electrostatic precipitation method offers an advantage in that the units can be thoroughly cleaned by washing and the possibility of contamination of other glazes is reduced. Where the same glaze is used over a long period, cleaning is reduced to washing down once a day with a hose. The power requirements are 75 watts for each unit capable of cleaning 2400 cfm of air.

Left, schematic principle and, right, diagrammatic cross-section of electrostatic precipitator

The sketch at the left shows how the air cleaner "magnetizes" impurities from the air. A fan draws the air to be cleaned through the inlet, between a series of grounded metal tubes, *B*. The dots marked *A* represent small wires between the cylinders, one wire between each pair. To these wires is supplied d-c voltage generated by a small power pack. This d-c voltage ionizes the air between the wires and the cylinders, creating what might be called an "electrostatic screen." All particles in the air passing through this screen are electrically charged.

Next, the air passes into the precipitating chamber in which are mounted a number of closely-spaced plates, parallel to the air stream. Alternate plates are connected to ground, the others to d-c source, setting up a second electrostatic screen between the plates. As air passes through the parallel plates this high intensity screen exerts a force on the charged particles in the air, drawing them to the grounded plates where they are deposited.

The sketch at the right is a diagrammatic cross-section of the precipitator. The dot and dash line of this figure shows the theoretical path of the particle which must travel the maximum distance. In theory, if the air velocity is made low enough to catch such a particle, 100 per cent efficiency would be obtained. Actually it is not this simple because all particles of a given size do not get the same charge and there are eddies in the air and nonuniformities in the field so that the actual efficiency does not show a sharp break at a given velocity. The electrostatic force acts to deposit the particle on the collecting electrode but when the particles touch the electrode most of this electrostatic force disappears so that the particle must be held by adhesion.



[2]The blackness test consists of drawing a measured quantity of uncleaned air through a given area of filter paper or cloth for a definite length of time. Air from the discharge side of the cleaning device is drawn through another paper or cloth at the same rate and the time necessary to produce equal blackness with the sample on the dirty side is measured. If, for example, time for a certain blackness is one minute and on the clean side the time is 20 minutes for the same blackness, the efficiency is said to be 95 per cent.

By Henry G. Schaefer*

Mr. Schaefer developed this scheme for sizing ducts —which involves the use of a single chart and slide rule—and makes possible computing the static of the system without resort to "Einsteinian" mathematics

A Rule-of-Thumb for

Scientific Duct Design

DESIGN of a ventilating system is a fascinating job. It embodies engineering (mathematical common sense), ingenuity and clairvoyance; it involves the certainty that a bare majority of the occupants of the ventilated space can be satisfied at a given time, and that it will cost "too much." And still those of us that handle air avidly enter into the design of each succeeding job with completely refreshed enthusiasm that refuses to entertain even the faintest tinge of the headaches of the last.

The writer, as late as the morning of the day on which this is written, had the fact brought to his attention that a certain lady still was discomfited by drafts in a "ventilated" room to which the branch dampers (felt edged) had been tightly closed for the preceding three days, in a desperate attempt to stop her wailing. Truly, there is nothing lower than most humans! And no one knows this better than the ventilating engineer.

But to get to the details of this discussion: The fan or blower is not often considered as a compressor, and air is not as completely likened to steam or water in our conception of what actually happens in the duct system as it should be. The concept of the fan as a compressor is a valuable one. After all, the pressure differential which exists between the register and the fan is what determines how much air is being handled and what power is necessary to achieve the air movement. It is equally obvious that the desideratum in the duct arrangement is that there shall be a constant resistance imposed on the moving air, and that abrupt changes in velocity, or alternating acceleration and deceleration of the moving gas must be avoided.

There are two general schools of designers, insofar as the methods of sizing ducts are concerned. The one uses the "velocity" method, in which velocities are arbitrarily selected, which process relies on skill and judgment, and the more popular "equal friction" system, in which all ducts are sized so as to impose a uniform frictional resistance to the flow of air per unit of length. There is little to be said against the latter method, and the most exemplary duct installations are sized on this basis.

One of the chief advantages of the "equal friction" method of sizing is that the frictional resistance of the system may readily be approximated, in that it is a function of the length of run, plus elbow and register resistance, whereas the net resistance of the "velocity sized" system is a complete mystery until this attribute is computed after the design is completed.

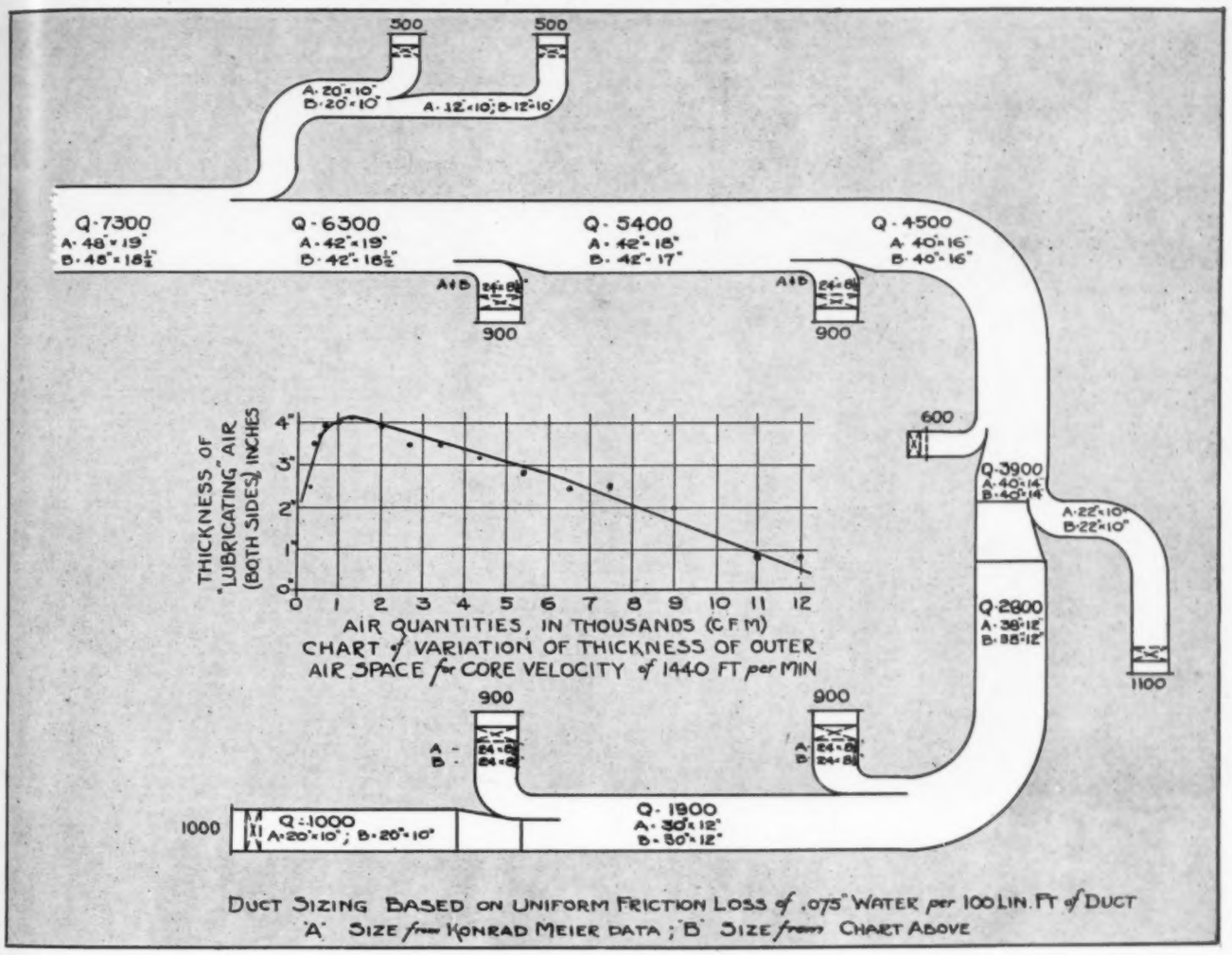
I believe that almost everyone has a natural aversion to subservience to "tables." Sizing charts, prepared carefully and tediously, are universally used in the sizing of ducts for equal friction. The result is that one loses his engineering independence, and the design of duct work must be done in the "laboratory," where the "brain" has assumed a planular aspect. In an effort to maintain his fast vanishing independence, the writer made some simple computations from series of analogous data, and offers the following easily remembered system for the sizing of duct work; a sort of scheme for "he who runs," as it were. The method is applicable, of course, to the office, where a single chart will take the place of the three now commonly used.

The bulk of the metal tonnage in ventilating and air conditioning duct installations is represented by systems handling 12,000 cfm or less. The particular short-cut described is for use within this quantity, and since even the largest and most complex system is merely an aggregation of smaller ones, this method is widely applicable. In the case described, a uniform loss of 0.075 in. of water per 100 ft of duct has been used as the basis. And, while this might appear as rather low to some folks, please remember that a sound installation must be conservative of fan power input, and must be quiet. It is easy to jam air through a small duct, but it will protest against such misuse. And you will hear the protest. Air is a docile servant until it is pushed too far, or too rapidly. And you can't make a noise without paying for the pleasure. Radio sponsors, machine bearings and amorous cats are ready to back up this claim.

In the accompanying table there are listed, in order, square duct sizes running from 8 to 36 in., their equivalent capacity round duct sizes, the quantities of air either will convey at 0.075 in. head loss per 100 ft, the average velocity of the gas in the square duct, and then a column, No. 5, that lists a "Core Area" for each size of duct.

This calls for explanation. The velocity of the air in the duct has been considered uniform within a "core" section, and non-existent at the periphery of the duct. In other words, that portion of the air being conveyed, which happens to be in contact with the duct walls, is considered here as a lubricating layer which is stagnant. At the same time, and only for the particular

*Engineer, Baker, Smith & Co., Inc.



DUCT SIZING BASED ON UNIFORM FRICTION LOSS of .075" WATER per 100 LIN. FT of DUCT
"A" SIZE from KONRAD MEIER DATA; "B" SIZE from CHART ABOVE

scope which this discussion covers, the moving core has been considered as a solid mass of air, all traveling at a uniform speed. The speed of 1440 fpm has been selected for the range of quantities involved simply because at this speed, each square inch of duct core section conveys 10 cfm and computations are thus simplified.

Column 6 lists the thickness of the stagnant layer of air adjacent to the duct wall, and indicated by *P* in the diagram. The last column No. 7, lists the frictional resistance imposed by a 90 deg elbow at the average velocity, (Col. No. 4), on which such data are based.

For convenience, the data in Column 6 have been doubled (to take care of both sides of the duct), and charted in the graph within the duct work sketch.

Now, the sizes prefaced *A* in the sketch have been taken from a chart of duct sizes for the standard friction loss of 0.075 in. For comparison, sizes determined by the core velocity of 1440 fpm have been marked *B*.

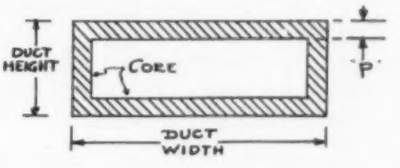
To see just what is done, consider the trunk that handles 7300 cfm. Since the width is presumed to be fixed at 48 in., let us subtract 2½ in. (from the graph) to get a core width of 45½ in. Since the core is delivering 10 cfm per sq in., the slide rule tells us that the core height should be 16 in. (730 divided by 45½) to which we add the 2½ in. lubricating strata allowance to get a duct height of 18½ in. And then, just to check up a little further, go back to our original data to find that 18½ in. is actually correct, but the chart has been read and transferred from round to square to rectangular so many times that an error has crept into the data.

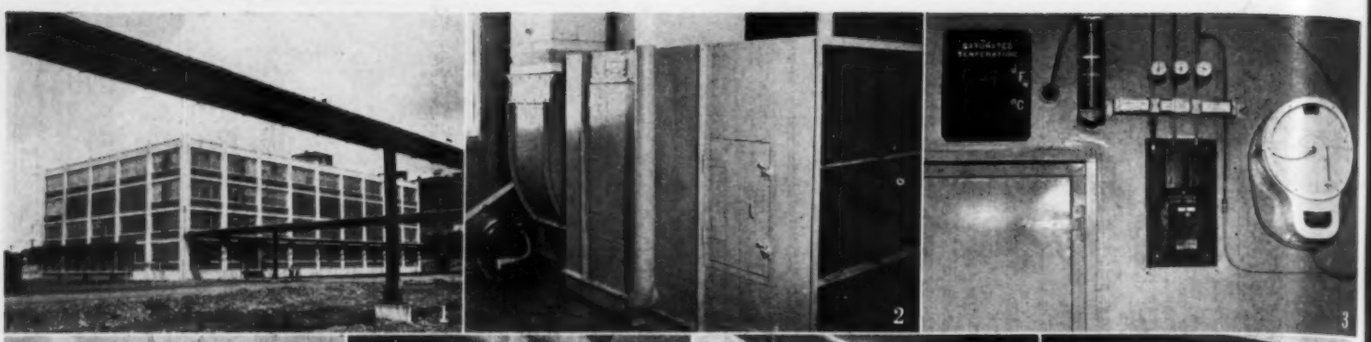
And so we go through the diagram, with just one small chart and a

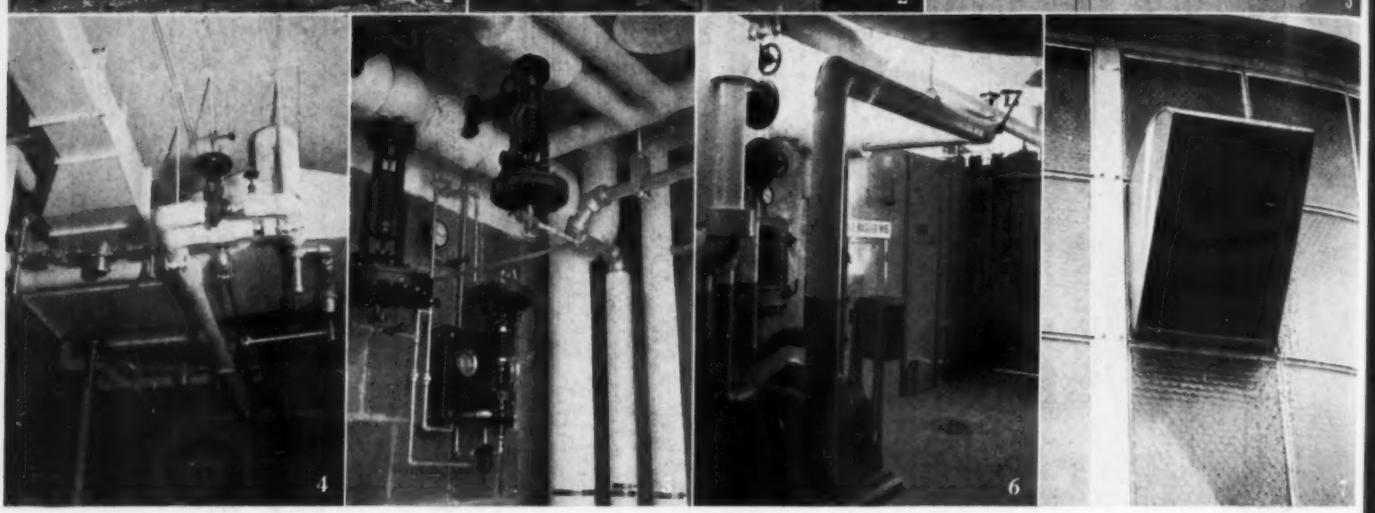
[Concluded on page 681]

Data for Use with Method

1 SIDE of SQUARE DUCT INCHES	2 DIA. of EQUIV. ROUND DUCT INCHES	3 AIR QUANTITY @ .075" HEAD LOSS C F M	4 AVERAGE VELOCITY FEET PER MINUTE	5 CORE AREA FOR 1440 Ft PER MIN VELOCITY	6 THICKNESS of AREA P INCHES	7 90° ELL FRICTION HEAD LOSS in RADIUS = 1½ DUCT WIDTH
8	8.8	300	540	30	1.26	.0065
10	11.	400	620	40	1.65	.0082
12	13.2	657	700	66	1.93	.0115
14	15.4	1,000	765	100	2.00	.013
16	17.6	1,400	825	140	2.07	.016
18	19.8	2,000	890	200	1.92	.017
20	22.	2,700	965	270	1.75	.019
22	24.2	3,400	1050	340	1.75	.022
24	26.4	4,300	1100	430	1.60	.024
26	28.6	5,400	1130	540	1.35	.026
28	30.8	6,500	1160	650	1.20	.027
30	33.	7,500	1220	750	1.30	.030
32	35.2	9,000	1250	900	1.00	.032
34	37.4	11,000	1300	1100	.40	.034
36	39.6	12,500	1334	1250	.40	.036







Builds Air Conditioned Film Warehouse

By H. W. Sachs*

AGFA ANSCO Corporation's new warehouse at Binghamton, N. Y., for the storage of films has been air conditioned to maintain dry bulb temperatures of 70 to 74 F and relative humidities ranging from 50 to 54 per cent the year around. Well water at 52 F and at a designed rate of 300 gpm is the refrigerating medium. Outside design conditions for summer were 75 F wet bulb and 90 F dry bulb, and for winter, —10 F.

The well water system was completely modernized about a year ago. There are four wells on the grounds, 80 to 100 ft deep, with deep well pumps having impellers 70 ft below the ground. They can pump 3,500,000 gallons per day. Constant pressure in the water lines at all times and economical pump operation is guaranteed through full automatic control.

By means of an equalization tank on top of a high house, which serves also as a reserve supply in case of current failure, and through a float level control, the pumps are started and stopped in seven combinations which deliver water quantities in close proportion to the plant demand. Operation of the system is under continuous supervision from two stations with a series of recording meters which indicate the proper relation between supply and demand. In case of failure, alarm signals call the operators, who can regulate the pumps by means of manual control.

*Chief Engineer, Agfa Ansco Corp.

The Air Conditioning System

The air conditioning equipment includes a 12,000 cfm outside air supply fan and an air washer and preheater situated on the first floor, a 9700 cfm recirculating fan unit on the first floor, an 8000 cfm recirculating unit on the second floor, a 7400 cfm unit on the third floor, and a 16,800 cfm unit on the fourth. Each is equipped with heating and cooling coils, and automatic temperature and volume controls. Special precautions are taken to prevent dust in the warehouse, which would be highly damaging to the product in storage. There are oil impregnated steel wool filters in front of the air washer, and felt filters in back of the supply fan; furthermore, each recirculating fan has its own oil impregnated filters.

Air from the main unit is conveyed by ducts to the recirculating units. To prevent dust from lodging in ducts, interiors are painted with glossy white enamel. On ducts too small for a man to enter for cleaning, easily removable bolted sections are provided so that a man can reach into adjoining sections to clean them.

The building, which cost $265,000 to construct, has 72,000 sq ft of floor space and a volume of 920,000 cu

ft. Exterior walls are of 8 in. brick and 4 in. terra cotta tile with a 1 in. air space between. The roof, which is flooded with water to reduce sun heat gain, is of 4½ in. concrete slabs, 1½ in. cork insulation, with asbestos felt, pitch and slag waterproof finish. All concrete beams above the windows have 1 in. cork insulation, and all outside concrete columns have 2 in. tile terra cotta insulation on the inside in order to prevent sweating during cold winter days. All windows are double sashed, and to prevent condensation between the two sheets of glass, small peep holes are provided to allow a small amount of outside air to enter the space; this allows an "air cushion" to balance with the outside air vapor pressure without cooling enough to cause sweating on the room side of the window.

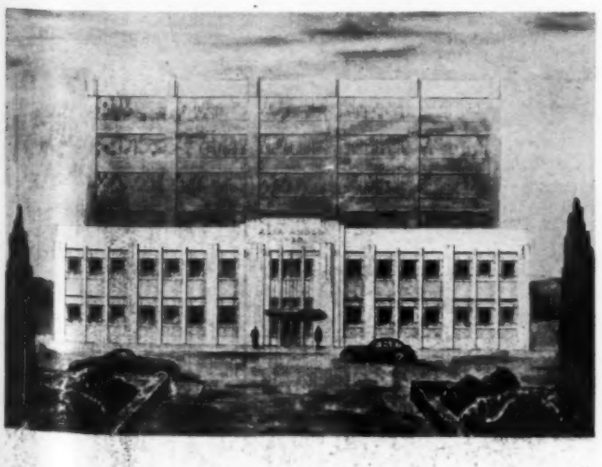
The consultants were Lockwood Greene Engineers, Inc., and the air conditioning system was installed by Buensod-Stacey Air Conditioning, Inc.

Air Conditioned Office Building

Agfa Ansco has under construction a four story air conditioned office and research laboratory building which will provide 34,000 sq ft of floor space. It is to be completely air conditioned and will have concealed air supply ducts in the office section and exposed in the laboratory, both with outlet ports in the window sills to prevent drafts in the rooms and to minimize sweating of windows in cold weather. Glass blocks will be used extensively for inside partitions to light up corridors not on an outside wall, and glass blocks will be used in skylights built as monitors with the glass blocks in the north side. A glass panel will be mounted in the ceiling to form an insulating air space between it and the monitor roof.

The same consultants and contractors are doing the new office and research laboratory.

On opposite page, (1) Agfa Ansco Corporation's new air conditioned film warehouse. (2) One of the recirculating units. (3) Dewpoint control station on main unit; the proper discharge temperature is marked on the blackboard. (4) Branch ducts for the offices, which have steam and electric heating coils so that temperatures higher than those in the warehouse can be maintained in office areas. (5) Heating steam reducing station. (6) The central conditioning unit with spray water circulating pump in foreground. (7) Automatic shutters discharge air from toilet rooms. *Below*—Artist's drawing of the office building which is under construction



Duct Design—

[Concluded from page 679]

slide rule, to get at once a correct sizing job that automatically compensates sizes for distortions over the normal range of depth-to-width ratios.

As a matter of fact, the chart is not entirely necessary. The writer, for instance, retains a mental picture of the high spots of the curve, and has repeatedly sized duct work with just a few minutes computation on the back of an envelope. Anyone can do that, of course, but by applying the method described, the duct will actually work properly.

And now to get a picture of the total static head that the fan will have to overcome in the duct work. A comparison of the data in Columns 1 and 7 will reveal that, with the exception of the two smallest sizes, in which the elbow friction is negligible, the resistance imposed by an elbow is a function of the equivalent square duct side in inches. A 12 in. square elbow eats up 0.0115 in. of water power; a 16 in. ell calls for 0.016 in. and a 36 in. ell wants 0.036 in.

So, to get the total static load, just scale off the length of the duct run from fan to farthest outlet, to which add the sum of all equivalent square duct elbow sides in inches, divided by 1000, and presto! the job is done. A duplex slide rule is definitely "the nuts" for the latter operation. In the case of the accompanying sketch, here's how it would be done:

1 register (300 fpm velocity)		0.03 in.
2 ells, 14 in.	28 in.	
1 ell, 20 in.	20	
1 ell, 24 in.	24	
	72 in.	0.072
120 ft duct at 0.075		0.09
Total static within duct		0.192 in.
10%		0.019
Total		0.211 in.

And don't forget that last 10 per cent. What happens on the job, to take care of the changed leader, or the new cold water line to the conditioner, always calls for the sheet metal worker to take in the line or to introduce an unforeseen offset.

By preparing charts for several ranges of friction loss, the engineer can determine the most suitable overall loss in the particular system, and design the duct work accordingly. This, in its larger aspect, also involves fan and motor sizes, and possibly heater and filter sizes. The weight of the duct installation, too, is an important consideration. This entire subject is highly complex, and is not given the consideration that it should have. The heart of the economics of air conditioning and of ventilation is bared by the question of whether a 3 or a 5 hp motor should be used. But that is another matter and is mentioned only as food for reflection.

Just another word before parting. In the elbow friction loss data used, the basis of throat radius equal to duct width was used. If shorter turns are used, a factor may easily be determined to cover other ranges.

Consulting Engineer Reviews

New York's New Building Code

By Walter L. Fleisher*

WHEN, after eight years of discussion, a new building code appears for a great city it is a matter of general interest. Consequently, I have been asked to comment on the new building code for the City of New York (which becomes effective January 1, 1938) as affecting heating, ventilating and air conditioning and its allied branches. Many of the passages pertinent to the industry are quoted below.

The code primarily is a safety one and, except in the plumbing, sprinkler and elevator sections, indicates nothing of design. The ventilation of toilets, the call for windows or mechanical ventilation in basements, the design of chimneys, the differentiation of high, medium and low temperatures, are all indicated, but a determination of our long-sought-for minimum of fresh air required in places of assembly and the question of the amount of recirculated air, so prominent in the Chicago code of 25 years, are to my mind fortunately omitted. Shall I say that our code makers are better plumbers, elevator and steel constructors, than heating and ventilating engineers, and have left us to our own resources?

Special Requirements for Heating and Ventilating Equipment Plans

Applications for permits to install furnaces and heating boilers coming under the provisions of 11.2.1 Combustion Appliances, shall be made on blanks furnished by the Superintendent. Each application shall be accompanied by plans showing the location, size and type of the apparatus, the construction of stack or chimney, the stack connection, the kind of fuel to be used, the method of operation and the method of preventing the emission of solids with the combustion gases. No apparatus shall be installed or used until a permit has been obtained from the Superintendent. Minor emergency repairs, which do not increase the capacity of, or involve any substantial alteration in such apparatus and which do not involve any alteration in the method of efficiency of *smoke prevention*, may be made without a permit.

Ventilation

Ventilation Required:

Structures or parts of structures (including those portions of multiple dwelling structures used for business purposes) hereafter constructed shall be provided with ventilation in rooms and spaces as hereinafter prescribed and in accordance with rules of the Board.

In the application of these provisions any room or space or portion thereof which has more than 50 per cent of its story height, between floor and ceiling, below the level of the nearest point of the nearest curb shall be considered as having insufficient ventilation for use as living quarters where any person or persons may sleep or be domiciled and such use shall be illegal.

In the application of these provisions stationary windows and stationary sash shall be construed as wall area and shall be given no credit as means of ventilation.

Where Special Ventilation is Required:

Where excessive heat may be created to the detriment of the occupants, or where steam, gases, vapor, dust or other impurities in the air, which may be injurious to health, may be generated in the course of commercial or other activities, rooms shall be ventilated in such manner as to render them harmless to any person therein.

Rooms in Residence Structures Hereafter Constructed

Windows Required:

Living rooms shall have one or more windows opening directly upon a street or other public space, or upon a court located upon the same lot or plot as the structure or conforming to the requirements of 5.1.12 Courts, provided that the width of such street or open space shall be at least the minimum required by 5.1.12, Courts (except as otherwise specifically stated in this section).

Ventilation of Toilets:

Every bathroom, toilet room or other room containing one or more water closets, or urinals, hereafter placed in any structure, shall be ventilated in at least one of the following ways: Windows opening to outer air. Windows opening on vent shafts or courts. Individual vent flues or ducts. Skylights. Mechanical exhaust ventilation.—By some approved system of mechanical exhaust ventilation of sufficient capacity to exhaust at least 40 cfm of air per water closet and per urinal for public rooms, and at least 25 cfm per private interior bathroom.

Separate exhaust flues shall be provided for every 250 ft of height of structures and these flues shall be of approved construction.

Openings into Interior Bathrooms and Water Closet Compartments:

Interior bathrooms and water closet compartments shall have fixed openings from adjacent rooms or corridors, or from other approved sources, ample to provide a sufficient flow of air to make exhaust ventilation effective.

Use of Pipe Shafts for Ventilation:

The use of pipe shafts as ventilating shafts is forbidden.

Ventilation of Inside Locker Rooms:

Inside locker rooms and other inside rooms of similar usage shall be provided with exhaust ventilation giving at least two changes of air per hour.

Ventilation of Refrigerating Plants:

Refrigerating plants shall be ventilated in accordance with the provisions of Chapter 10, Code of Ordinances, City of New York.

Ventilation of Inside Cooking Spaces:

Inside spaces where cooking of any kind is done shall have a mechanical exhaust ventilation of 3 cfm of air for each sq ft of floor area but in no case less than 150 cfm of air. The exhaust shall be collected in a sheet metal flue connected to an independent common flue in a fireproof shaft. Such flues shall be of No. 16 U. S. gage sheet metal, or terra cotta, and shall be connected to a separate fan.

When two or more such flues are enclosed in a single shaft, each shall be covered with fire retarding materials as prescribed by the rules of the Board.

*Consulting and Advisory Engineer. Member of Board of Consulting and Contributing Editors.

Index for Ventilation

Spaces above or below grade, with or without windows, designed for human occupancy only as defined in 1.79, Human Occupancy (except as otherwise prescribed in 5.1.4. Rooms in Residence Structures Hereafter Constructed) shall have ventilation either from windows or from mechanical means, or from both, in accordance with the following Index and requirements:

Cubic foot contents per person plus 10 times floor area per person in square feet plus 100 times the entire masonry window openings per person in square feet equals Index.

For Rooms with Windows:

If the Index is less than 300 there shall be supplied an amount of fresh air equal to 2½ cfm per sq ft of floor area, and an air exhaust of 2 cfm per sq ft of floor area.

If the Index is between 300 and 520 there shall be supplied an amount of fresh air equal to 2 cfm per sq ft of floor area, and an air exhaust of 1½ cfm per sq ft of floor area.

If the Index is between 520 and 850 there shall be supplied an amount of fresh air equal to 1½ cfm per sq ft of floor area and an air exhaust of 1¼ cfm per sq ft of floor area.

If the Index is between 850 and 1650 there shall be required an air exhaust only of 1 cfm per sq ft of floor area.

If the Index is above 1650 no mechanical ventilation is required.

No window shall be credited as such under the provision of this Article unless such window opens directly upon a street or other open public space or upon a court located on the same lot or plot and conforming to the requirements of this Article for courts, 5.1.12, Courts.

Show windows and other stationary windows shall be considered as wall area in calculating the Index.

For Rooms Without Windows:

If the Index is below 850 the requirements shall be the same as for rooms with windows.

If the Index is between 850 and 1650 there shall be required an air supply of 1 cfm per sq ft of floor area and an air exhaust of 1 cfm per sq ft of floor area.

If the Index is over 1650 there shall be required an air supply of ⅓ cfm per sq ft of floor area and an air exhaust of ⅓ cfm per sq ft of floor area.

Interior partitions shall have transoms or equivalent openings, and when partitions occur 30 ft or more away from a window or similar opening, the room so formed shall have ventilation based upon the Index without windows.

Spaces below grade with or without windows, designed for live storage of five or more cars propelled by gasoline engines or other internal combustion engines and operated within the storage space under their own power shall have provision for at least four changes of air exhaust per hour by mechanical means, with provision for a corresponding air inflow from an uncontaminated source. Two changes of the four shall be taken from near the floor.

Spaces above grade with or without windows, designed for the same purpose shall have pro-

Features of New York City's new building code—which becomes effective January 1—of particular interest to ventilating, heating, and air conditioning engineers are briefly reviewed by a consulting engineer of that city. . . . . The code in general and its preparation are unusual in many respects. For instance, it will permit fusion welding in New York City for the first time in place of riveting or bolting

vision for at least four changes of air per hour by mechanical means or, shall have adjustable openings near the floor on all outside and court walls. Adjustable openings shall be at least 6 in. by 4 in. and within 6 in. above the floor, and shall be spaced between wall columns and at least every 16 ft where columns do not occur. Such spaces shall also be subject to the requirements of 5.13, Where Special Ventilation is Required.

Elevator pits below floor levels shall have mechanical exhaust ventilation taken from near the bottom of the pits.

Combustion

Discharge of Solids Forbidden:

Furnaces coming under the provisions of 11.2.1. Combustion Appliances, all rubbish burners and incinerators shall be so designed that under normal conditions of operation they will not discharge smoke, soot, cinders or fly ash or other residue in such quantities as to cause annoyance to the public or injury to business or property.

Ash and Soot Collectors Required:

Whenever special considerations make necessary the operation of furnaces which inherently cannot avoid the generation of cinders, fly ash, or soot, the smoke flues serving such furnaces shall be provided with approved cinder catchers or fly ash, and soot collectors, so designed and installed as to be capable of securing the following conditions:

If coal is used as fuel, the maximum amount of cinders contained in the combustion gases discharged into the free air shall be 400 grains per 1000 cu ft of combustion gases.

If powdered or pulverized coal is used as fuel, the maximum amount of fly ash contained in the combustion gases discharged into the free air shall be 400 grains per 1000 cu ft of combustion gases.

If oil is used as fuel, visible discharge of soot, smoke or other forms of incomplete combustion is prohibited.

Tests of Amount of Solids Discharged:

In case of dispute as to whether combustion appliances are meeting the requirements of 11.2.2, Discharge of Solids Forbidden, and 11.2.3 Ash and Soot Collectors Required, the Superintendent may require the owner of a structure to have a test made at the owner's expense by a disinterested person acceptable to the Superintendent in order to determine the amount of cinders, soot and fly ash contained in the combustion gases. Tests shall be made as follows:

To determine the amount of cinders and fly ash contained in the combustion gases, the combustion gases shall be exhausted by a calibrated fan, at points where average results will be obtained, and discharged by the fan through muslin or flannel bags of large size and fine weave so as to collect all cinders or fly ash and ascertain the weight thereof.

The maximum permissible amount of unconsumed carbon in the combustion gases where oil is used as fuel shall be 400 grains per 1000 cu ft of combustion gases determined by a *thimble test.*

Low Temperature Chimneys:

Chimneys constructed to convey products of combustion having a temperature of 600 F or less at the point of entrance shall be classified as "low temperature chimneys."

The following heat producing devices shall be included among those requiring low temperature chimneys; bakers' ovens; boiling vats; candy furnaces; coffee roasting ovens; cooking ranges; core ovens; cruller furnaces; drying furnaces for spent materials; feed drying furnaces; fertilizer drying ovens; forge furnaces; gas producers; hardening furnaces (below dark red); hot air engine furnaces; hot air heating furnaces; hot water and low pressure steam heating boilers; japanning ovens; metal drying furnaces lead melting furnaces; nickel plate furnaces; paraffine furnaces; rendering furnaces; rosin melting furnaces; stereotype furnaces; sulphur furnaces; type-foundry furnaces; wood drying furnaces, and wood impregnating furnaces.

Brick Chimneys:

The walls of brick chimneys used for low temperatures shall be at least 8 in. thick, and shall be lined with fire clay flue lining (except that in dwelling house chimneys for ordinary stoves, ranges and fireplaces the thickness of brick may be reduced to 3¾ in. and except that where boiler flues pass open fireplaces, the thickness of brick between flue lining and fireplace opening may be reduced to 3¾ in.) For medium temperatures they shall be at least 8 in. thick, lined with an inner course of fire brick 4½ in. thick laid in fire clay mortar or approved high temperature cement to the top or the first 50 ft from the entrance. For high temperatures they shall be built with double walls, each at least 8 in. in thickness with a minimum air space of 2 in. between them. The inside course of the interior walls shall be of fire brick laid in fire clay mortar or high temperature cement.

Boiler or Furnace Room Air Supply

Rooms in which boilers or furnaces are located shall have adequate means for fresh air supply to insure proper combustion. Direct connection of air inlets to the ash pits or combustion chambers of boilers or furnaces is forbidden (except where forced draft is employed).

Btu Required for Heating Air

This table shows the quantity of heat in Btu required to raise 1 cu ft of air through any given temperature interval:

External Temperature Degrees F.	Temperature of Air in Room									
	40	50	60	70	80	90	100	110	120	130
-40	1.824	2.052	2.281	2.509	2.738	2.967	3.197	3.424	3.654	3.882
-30	1.559	1.782	2.005	2.229	2.452	2.675	2.899	3.125	3.346	3.570
-20	1.306	1.524	1.742	1.960	2.179	2.397	2.615	2.834	3.053	3.271
-10	1.065	1.278	1.491	1.704	1.918	2.132	2.345	2.558	2.772	2.986
0	0.833	1.042	1.250	1.459	1.668	1.877	2.085	2.294	2.504	2.713
10	0.612	0.817	1.020	1.224	1.428	1.633	1.837	2.042	2.246	2.451
20	0.399	0.599	0.799	0.999	1.199	1.399	1.599	1.800	2.000	2.200
30	0.196	0.391	0.587	0.783	0.979	1.175	1.371	1.567	1.764	1.960
40	0.000	0.192	0.384	0.576	0.768	0.960	1.152	1.344	1.537	1.729
50	.....	0.000	0.188	0.376	0.565	0.753	0.941	1.130	1.319	1.507
60	.....	.....	0.000	0.185	0.369	0.554	0.739	0.924	1.108	1.293
70	.....	.....	.....	0.000	0.181	0.362	0.544	0.725	0.906	1.008

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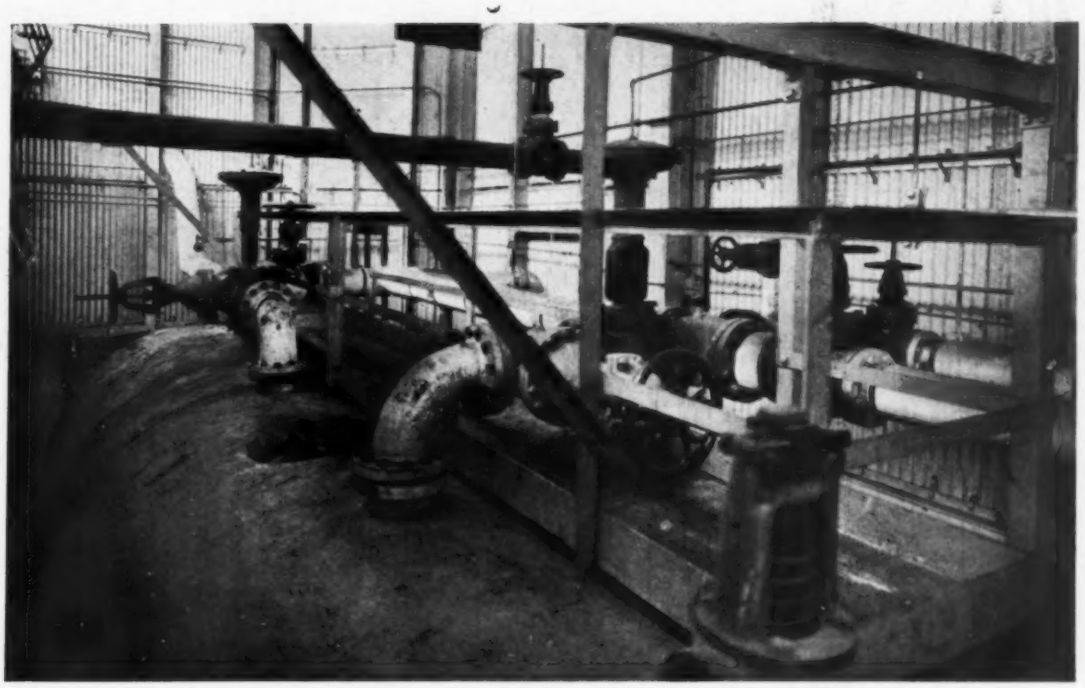
How Steam Storage Can Be Applied to Process Steam Piping Systems



Steam accumulator, showing steam inlet and outlet piping and air actuated regulating valves

THE successful operation of a steam storage system in a prominent industrial plant has resulted in a second installation by the same company. This company has several plants engaged in the manufacture of glass and paints. The recent application of steam storage in its Missouri works has considerably improved the efficiency of its manufacturing operations.

Before the accumulator was installed, the steam demand at the Missouri plant averaged 12,000 lb per hr but fluctuated during an hour between the rates of 8600 and 20,000 lb. These surges included three peaks, lasting about six minutes each when the flow jumped suddenly from minimum to maximum. This occurred because of autoclaves which were operated on the batch basis at 20 minute intervals. A steam storage system is ideal for such a variable load since it eliminates the peaks and permits boiler operation at the base load average of 12,000 lb per hr.

A recent installation and its results are briefly described, and it is shown how the steam storage unit prevents excessive pressure drop in the piping . . . Diagrams indicating the application in two industries—brewery, paper—are presented

The steam accumulator for this plant is of class 1 welded construction 28 ft long, 7 ft in diameter, 1000 cu ft in volume and is designed to store 1250 lb of steam. Boiler pressure is 130 lb per sq in. and the autoclaves require steam at 85 lb pressure per sq in. The accumulator pressure varies between these limits. Its principle of operation is simply that of storing the heat energy of steam in a large quantity of hot water under pressure, at saturation temperature, and of releasing the energy in the form of steam when the pressure is diminished. Pressure in the accumulator increases with the amount of steam stored in the water contained therein.

The accumulator is connected between the main steam header and the supply line to the autoclaves at a distance of about 400 ft from the boilers. Air operated regulating valves are installed on the accumulator inlet and outlet lines and are each connected by small compressed air lines to pilot heads, or relays, on the instrument board. A third pilot head located between the other two is connected directly to the accumulator side of the inlet line. These three air actuated pilots together automatically control the admission or release of steam in the accumulator.

For these operating conditions, the boiler plant may be 250 hp smaller, if used in conjunction with such a steam storage system, than it would need to be if operated without any steam storage. The first cost of the complete installation, either with or without the accumulator, is about the same. However, the boiler firing equipment alone could not meet sudden peaks requiring instantaneous doubling of capacity. If this method of operation should be attempted, the steam pressure would decrease considerably when the peak demand first came on.

As a matter of fact, in this particular plant, the process-

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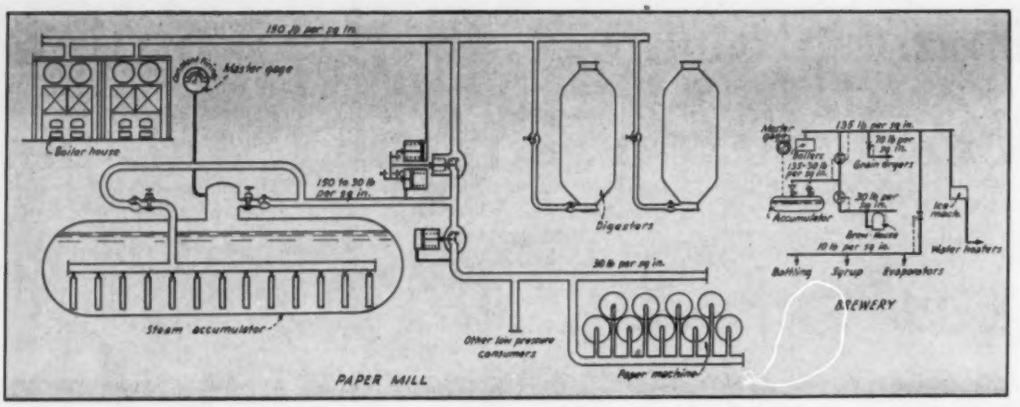
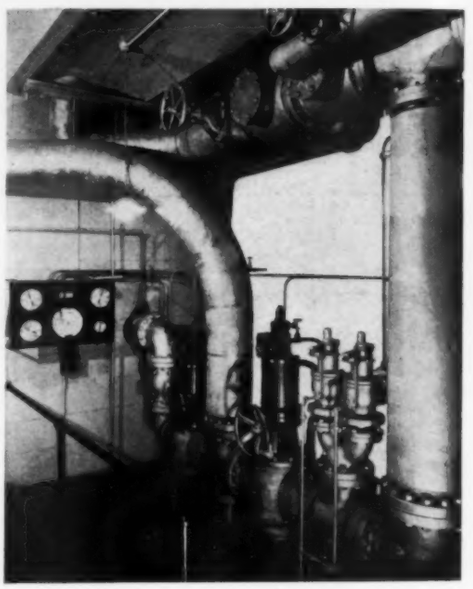


Steam storage systems for a paper mill and a brewery

ing machines are situated quite a distance from the boiler at the end of a long steam line. Before the installation of the accumulator, the sudden demand for steam, when the autoclaves commenced to operate, caused excessive pressure drops in the pipe line with a consequent loss in production of the autoclaves. Upon the addition of the accumulator, steam flowed from the boilers at a steady, average rate, very much lower than the peak requirements for steam. As a consequence, steam is available at the autoclaves, as taken from the accumulator, at pressures considerably higher than was the case before the installation of the accumulator. A further advantage of the steady operation of the boiler, held at average load by means of the steam storage system, is the improvement in the efficiency of steam generation with material savings in operating costs.

Representative piping and control arrangement for a steam accumulator. The first valve is an overflow valve which prohibits the accumulator system from taking steam from the boilers when the pressure in the boiler main becomes less than 135 lb per sq in. The next valve is the reducing valve between the accumulator and a low pressure steam main. The pipe between the two valves is connected to the accumulator. In the left background, the master meters and recording pressure meter for the system



Blower Filter Unit—

[Concluded from page 665]

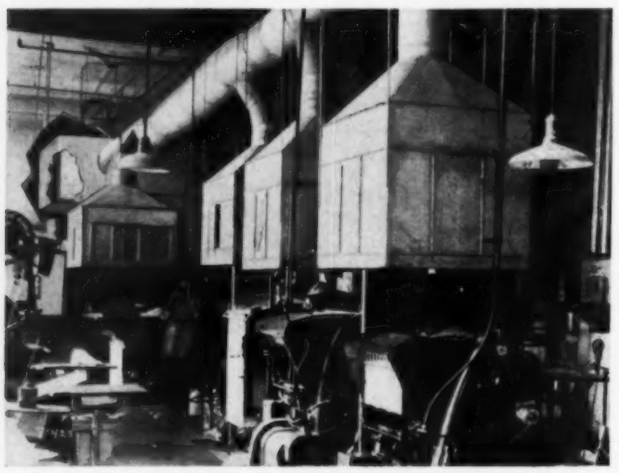
The printing company therefore installed a blower filter unit and system of duct work to collect the surplus spray material, filter it out of the air and return the clean air to the press room. A standard 20 in. blower driven by a 1 hp motor is used. Size of the press room is 32x64 ft with 14 ft ceilings, and the blower is operated to accomplish a complete change of air every four minutes.

Three standard filters were placed in one bank in the cabinet housing the blower fan. This cabinet is located near the ceiling in a stock room. It is suspended from the ceiling and takes up no working space. Air, after leaving the blower, returns to the press room through a doorway in the partition separating the two rooms.

The results are most satisfactory. The air is clean at all times, and working conditions are again O. K. The filters prove very efficient in separating the fine dust from the air and rid the shop of much other floating matter detrimental to fine work. Six filters were purchased—three for the operating bank and three for spares to save time in changing and cleaning. An inexpensive twin metal tank is used to souse the dirty filters into for cleaning and re-oiling.

A benefit not taken into account as a primary purpose of this installation, was the added comfort created for the workmen by constantly keeping the air in circulation.

The ducts and hoods are out of the way and do not interfere with the operation of the presses.



Blower filter unit for cleaning press room air

Photo courtesy Air-Maze Corp.

sary in a small installation may be as high as 40 per cent of the amount of radiation installed, whereas on very large jobs this percentage may be as low as 15 per cent.

"A gas fired boiler is so sensitive to water temperature or steam pressure regulation, as well as automatic room temperature control, that in most cases adding 25 per cent for "pick-up" load will be ample for average continuous residence heating. Where the building is irregularly or periodically heated, either by automatic or hand control, this percentage should be increased to 50 per cent or 60 per cent.

"The most accurate method for selecting the proper size of boiler for any given installation is to determine the exact amount of standard column radiation required to heat the building to the temperatures required, and then to add the actual heat losses from covered or uncovered piping in units of sq ft of standard column radiation.

"The boiler is selected then by adding the piping and starting allowance to the installed radiation, either in terms of sq ft or Btu. From the manufacturer's catalog select the boiler with nearest rating larger than the estimated requirement.

"In the event that the owner does not wish to install a thermostatically controlled system, the procedure is somewhat different. In place of adding 25 per cent for risers and returns and 25 per cent for quick start, it will be found that, unless the boiler is selected on the basis of a 100 per cent allowance for manual control, the operation will not be satisfactory. The 100 per cent includes the allowance for risers and returns, no separate addition being necessary in this case. With manual control, the temperature fluctuations within the building are quite considerable because the reaction of the human body to temperature change is not nearly so sensitive as that of a thermostat. A greater amount of boiler capacity is therefore necessary to effect a quick return to comfortable temperatures."

Manufacturers of gas heating boilers usually rate their products in terms of *A. G. A.* steam or water radiation (240 or 150 Btu respectively), with instructions that the load be computed as described above and a boiler selected which has a rating equal to or slightly greater than the connected load plus piping tax and warming-up allowance. Where gas boilers are used the domestic water supply commonly is heated in separate gas water heaters, under which circumstances it is not necessary to add the water heater load in figuring boiler capacity.

In selecting a gas boiler by the *A. G. A.* rating method it should be borne in mind that the output is limited by gas burning capacity as well as by boiler heating surface. In the writer's opinion it is better practice to select a somewhat larger boiler and then throttle down the gas and air adjustments as required to obtain optimum operating conditions. This will tend to give a low stack temperature with high efficiency, and at the same time provide reserve capacity in case the job was underestimated or more load is added in the future. Provision of some capacity beyond the absolute minimum recommended for automatic control is desirable also to furnish quick pick-up if the building temperature is lowered at night as is usually the case with gas firing. The writer believes, therefore, that it is advisable with automatic control as well as with manual to follow the instructions given in the last paragraph quoted from the *A. G. A.* bulletin and add at least 100 per cent to the standing radiation to provide properly for piping tax and pick-up.

[*Concluded*]

Rules for Heating Boiler Selection Concluded in This Month's Heating ✦ Piping and Air Conditioning Summary Sheets

[Pages 17-20 were published last month]

Selecting the Right Size Heating Boiler†

By Sabin Crocker*

A rule regarding furnace volume has also been established in the Simplified Practice Recommendation for Steel Horizontal Firebox Heating Boilers mentioned previously. The furnace volume for a boiler whose rating does not exceed 17 times the sq ft of heating surface in which gas, oil, or bituminous coal, stoker fired, is burned, shall not be less than 1 cu ft for every 140 sq ft of steam rating. Furnace volume for furnaces in which solid fuel is burned is defined as the cubical content of the space between the bottom of the fuel bed and the first plane of entry into or between the tubes. Furnace volume for furnaces in which pulverized fuel, liquid, or gaseous fuel is burned shall be considered as the cubical content of the space between the hearth and the first plane of entry into or between the tubes.

The furnace heights called for in Table 13 are not always realized in actual practice, especially when stokers have to be fitted in existing boilers with a minimum of rearrangement. The writer knows of several 36 in. cast iron boilers which have been fitted with underfeed stokers where the tops of the retorts were installed at the former grate level and satisfactory operation obtained with a furnace height of not to exceed 26 in. This is less by the lettered dimension *A* denoting the required depth of the stoker pit or height of raised setting than the furnace height of 48 to 51 in. called for in the section of Table 13 designated "Compact Welded Boilers" which comes the closest to fitting this condition. Many compact welded boilers show a deficiency in this respect similar to that of cast iron boilers, although not always to the same extent.

The average furnace height for steel horizontal firebox heating boilers as given in the simplified practice recommendation is as follows: For boilers in which bituminous coal, stoker fired, is burned, the average height shall not be less than determined graphically by Fig. 3 or mathematically by the following formula:

$$H = \sqrt{\frac{R}{22.5}} + \sqrt{\frac{R}{A}}$$

where H = average furnace height in inches as determined by the following formula:

$$H = \frac{12F}{A} = \frac{12F}{WL}$$

R = stoker fired boiler rating in sq ft steam radiation,

A = plan area of fire box in sq ft, measured at the bottom of the fuel bed,

F = furnace volume in cu ft,

W = average width of furnace in ft, measured at the bottom of the fuel bed,

L = length of furnace in ft. If the furnace is longer than the fuel bed or contains a bridge wall, the total length of the furnace may be used except that this length shall not exceed 2½ W.

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†Summarized and revised from a series of three articles published in Heating, Piping and Air Conditioning, February-March-April, 1932

Here is the last installment of this series of "summary sheets," on this and the preceding page. The purpose of these sheets is to make available for quick reference for everyday use information needed in heating, piping and air conditioning work. . . . For complete information, refer to the original article from which these data were obtained, as the purpose of these summaries is not to take the place of the article, but rather to put the essentials into convenient reference form. . . . The Editors will appreciate your suggesting what type of material you'd like presented in this way. . . . Address HEATING, PIPING AND AIR CONDITIONING, 6 North Michigan Avenue, Chicago, Ill.

In order to get the required furnace height with cast iron or compact welded boilers it usually is necessary either to pit the stoker, or, where water-line conditions and headroom permit, to raise the boiler on a brick foundation setting. The latter course has advantages, where practicable, in giving a better working space around the boiler and stoker. On the other hand where a monorail conveyor or other handy device is not provided for handling coal and ashes, it may be more convenient to fill the coal hopper of a pitted stoker than to shovel coal by hand into the hopper of a raised setting job. If the size of the system permits, it is desirable to have the hopper large enough to hold at least an 8 hr coal supply to carry the stoker through the night without attention.

Oil Fired Boilers—With oil fired boilers due care must be exercised to see that the oil burning equipment has ample capacity to develop the required boiler output. It is desirable to have the oil burner somewhat oversized rather than under the expected requirements, since the maximum rate of oil burning is definitely limited by the design of the burner.

With a full automatic burner it is desirable to use a larger boiler than would be required with coal firing, since the oil fire is operating at its maximum rate while on and adjusts itself to weather conditions by the length of time between periods of operation. This is quite different from coal firing where it is seldom necessary to push the fire to its maximum intensity, and most of the fuel used during the season is burned in a slow fire. Consequently a somewhat larger boiler is required with oil to obtain as low a stack temperature as would correspond to normal operation with coal.

With semi-automatic or with manually operated oil burners it is not necessary to operate them at maximum output all the time, as the fire can be adjusted to suit load requirements. Under these conditions the necessity for a large boiler is not so evident, although it may be found desirable from a standpoint of fuel saving.

The amount of combustion space required for burning oil depends to a considerable extent on the design of the burner and furnace. A good general rule is that there should be 1 cu ft of furnace volume for each 1½ to 2 lb of oil burned per hr. There are successful oil burner and boiler combinations on the market, however, which do not require this furnace volume. The absence of the incandescent fuel bed existing with a solid fuel fire lessens the necessity for large furnace volume and extensive radiant heating surface. Liberal provision of convection surface seems more important with oil and gas firing than large furnace volume and the present tendency is for ample heating surface in the flue passages.

The Simplified Practice Recommendation previously referred to allows 17 sq ft of 240 Btu radiation per sq ft of boiler heating surface where oil or gas is burned or where solid fuel is mechanically fired, as in stokers. This load is 21.5 per cent greater than the *Institute's* recommendation for hand fired boilers burning solid fuel. While it may be possible to force boilers with oil, gas or stoker firing to this extent, it usually is not desirable with oil or gas from an economy standpoint. Consequently the general trend seems to be contrary to this particular recommendation.

Where an oil burner is installed with a refractory lining inside the combustion chamber, pains should be taken to see that the refractory setting does not screen an undue amount of the radiant heating surface in the furnace, as available radiant surface should be utilized to the

fullest extent. Many cast iron boilers are built without base sections and have water legs coming down to and resting on the floor. This water leg surface has a high rate of heat absorption if exposed to direct radiation from the oil flame, and should not be screened more than necessary. For this reason such boilers should be installed on a raised setting, or the burner pitted sufficiently to keep as much of the refractories as possible below the water legs. The setting need not be so high for oil burning since oil can be burned satisfactorily with less furnace volume than is desirable for the smokeless combustion of high volatile coal. The writer knows of several instances where the performance of oil burning boilers was greatly improved by changing the setting in this way. Usually with existing installations this is most easily accomplished by pitting the burner.

Gas Fired Boilers—Selection of the right size gas boiler is discussed at some length in the bulletin on house heating (third edition) of the *American Gas Association*, from which the following is quoted:

"Unlike boilers designed to burn solid fuel, the question of the firing period or available fuel capacity is not a factor in estimating the size of gas boilers, which instantly deliver their full rated capacity whenever the gas is turned on. The highest operating efficiency is obtained when the rated output of a gas boiler most nearly equals the exact heating requirements of the building.

"It has been the common practice to assume that the extra tax imposed on the boiler due to piping installed is about 25 per cent of the amount of column radiation and to add a further 25 per cent to this total to take care of starting load or "pick up" under thermostatic control.

"The proportionate amount of piping to radiation is considerably greater in a small than in a large installation, and while 25 per cent in general instances fairly represents the tax imposed, yet upon a percentage basis the additional load imposed on the boiler by the amount of piping neces-

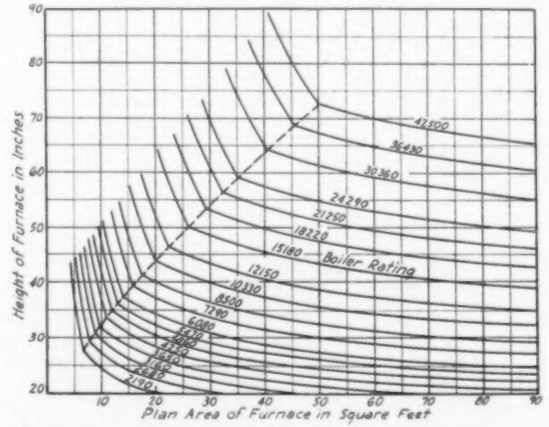

Fig. 3—Furnace heights for stoker fired boilers, bituminous coal

Solving Piping Flow Problems

Eliminating Cut-and-Try Methods When Using the Reynolds' Number

By William Goodman*

AS mentioned in concluding the first part of this discussion last month, when it is necessary to compute the pressure drop for a known weight of fluid flowing through a given pipe size, Formula 7 cannot ordinarily be used because the final pressure is unknown and, hence, the average density cannot be computed. Under these conditions, Formula 6 is usually used.

Nevertheless, the simpler Formula 7 can be used even for problems of this type by utilizing the "equivalent pressures," as explained in the following paragraphs. In this way, the methods of using the modified Reynolds' numbers previously described, together with the friction factors of Fig. 1[2], can be applied even where the pressure drop is relatively large.

When the final pressure is to be found, instead of using Formula 6, Formula 11 below is first used to find the final "equivalent pressure."

$$P_1 - P_E = \left(\frac{4}{\pi}\right)^2 f \frac{L}{D^5 d_1} \frac{W^2}{2g} \quad \text{.....[11]}$$

This is exactly the same as Formula 4 (Table 1). It is apparent, therefore, that the final "equivalent pressure" is nothing more than the final pressure which would be obtained if the density remained constant and equal to the initial density. However, if the density does not remain constant, the factors in Table 3 can then be used to find the actual final pressure from the final equivalent pressure computed by means of Formula 4.

The final equivalent pressure is related to the actual final pressure by Formula 12, the derivation of which is given in Appendix 3. The factors in Table 3 were computed from this formula.

$$\frac{P_2}{P_1} = \sqrt{2\left(\frac{P_E}{P_1}\right) - 1} \quad \text{.....[12]}$$

When using Table 3, *absolute pressures* must be used; gage pressures will lead to incorrect answers. However, either gage or absolute pressures may be used in Formula 4.

Example 2: 200 lb per min of compressed air at an initial pressure of 125 lb ga is to be delivered through a 2½ in. standard weight steel pipe. The temperature of the air is 70 F = 460 + 70 = 530 F absolute. The length of the pipe is 500 ft. Find the pressure at the end of the pipe line.

Solution:

Initial pressure = 125 + 14.7 = 139.7 lb per sq in. absolute. Using the gas law,

$$P_1 V_1 = WBT$$

where

P_1 = pressure, lb per sq ft
V_1 = volume, cu ft
W = weight, lb
B = a constant (53.35 for air)
T = absolute temperature, F

$$\frac{W}{V_1} = d_1 = \frac{P_1}{BT}$$

$$d_1 = \frac{139.7 \times 144}{53.35 \times 530} = 0.712 \text{ lb per cu ft initial density}$$

$$R_p = 378.8 \frac{W}{Du} \qquad \text{(Formula 1a)}$$

Referring to Fig. 2 viscosity of air at 70 F, $u = 0.0185$ centipoises.

Referring to Table 2, for a 2½ in. pipe, $D = 2.469$ and $D^5 = 91.75$.

$$R_p = 378.8 \times \frac{200}{2.469 \times 0.0185} = 1{,}660{,}000$$

Referring to Fig. 1, for commercial pipe, $f = 0.016$.

$$P_1 - P_E = 0.01209 f \frac{L}{D^5} \frac{W^2}{d_1} \qquad \text{(Formula 4a, same as 11)}$$

$$139.7 - P_E = 0.01209 \times 0.016 \times \frac{500}{91.75} \times \frac{40{,}000}{0.712}$$

$$139.7 - P_E = 59.2$$

$$P_E = 80.5 \text{ lb per sq in. absolute}$$

$$\frac{P_E}{P_1} = \frac{80.5}{139.7} = 0.576$$

Referring to Table 3, for $\frac{P_E}{P_1} = 0.576$,

$$\frac{P_2}{P_1} = 0.390$$

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*The Trane Co. Member of Board of Consulting and Contributing Editors.

Part 2. Part 1 was published in the October, 1937, issue, pp. 625-629.

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[2]See Part 1.

Symbols

D = Diameter of pipe
d = Density of fluid
d_1 = Initial density
d_2 = Final density
d_a = Average density
f = Friction factor
g = Gravitational constant, 32.2
L = Equivalent length of pipe (includes loss due to fittings and also entrance and exit losses)
P_1 = Initial pressure.
P_2 = Final pressure
$p_F = \frac{P_1 - P_2}{L}$, pressure drop per foot of pipe length
P_E = Final equivalent pressure
R_P = Basic Reynolds' number to be used in finding *pressure* drop
R_W = Modified Reynolds' number to be used in finding *weight* of fluid
R_D = Modified Reynolds' number to be used in finding required *diameter* of pipe
u = Viscosity of fluid
U = Velocity of fluid
W = Total weight of fluid flowing through pipe in a unit of time

Note: For units, see bottom of Table 1.

$P_2 = 0.390 \times 139.7$

= 54.5 lb per sq in. final absolute pressure at outlet of pipe, or 54.5 — 14.7 = 39.8 lb ga.

Criterion for Applying Formula 7

Formulas 6, 7, and 11, for the flow of a gas whose density experiences a large change, are valid only for "long" pipes. Formula 6 is derived from a somewhat more complex formula containing a factor which becomes very nearly equal to one for long pipes. This is discussed further in Appendix 4. Therefore, when using Formulas 6, 7, and 11, it is necessary to have some criterion as to whether or not they will give accurate results for a given set of conditions. The data in Fig. 3 provide such a criterion. The basis of this figure is explained in Appendix 4. The value of N, which is the abscissa of Fig. 3, is defined by the following formula:

Consistent units:

$$N = f\frac{L}{D} \qquad [13]$$

Mixed units:

$$N = 12\,f\frac{L}{D} \qquad [13a]$$

After a problem has been solved, the values of N and $\frac{P_2}{P_1}$ can be computed.

Example 3: Take the conditions of Example 2 and determine whether Formula 11 can be used.

Solution: From Example 2, $f = 0.016$; $L = 500$ ft; $D = 2.469$ in.

$$N = 12\,f\frac{L}{D} \qquad \text{(Formula 13a)}$$

$$= 12 \times 0.016 \times \frac{500}{2.469} = 38.9.$$

From Example 2, $P_1 = 139.7$ lb absolute; $P_2 = 54.5$ lb absolute.

$$\frac{P_2}{P_1} = \frac{54.5}{139.7} = 0.39$$

Referring to Fig. 3 for $\frac{P_2}{P_1} = 0.39$ and $N = 38.9$, the percentage error in using either Formula 6 or 7 amounts to about 5 per cent.

In other words, in the preceding example for a given flow, the actual pressure drop will be 1.05 times the pressure drop obtained in Example 2. On the other hand, if the pressure drop is fixed by external conditions, the weight flowing through the pipe line will be reduced to 1 divided by the square root of 1.05, or 97.7 per cent of the weight given in the example.

If Fig. 3 shows that the error under a particular set of conditions is larger than is permissible, then the more complicated formulas given in Appendix 4 must be used. However, since these more complicated forms are to be used only when the length of pipe is relatively short, it becomes a question whether isothermal flow[3] can be maintained in a short pipe line. In order to maintain isothermal flow when a large pressure drop occurs in a pipe line, there must be enough exposed pipe surface so that a sufficient quantity of heat can be transferred from the surrounding atmosphere to the flowing gas through the surface of the pipe. It would seem that this condition could hardly be satisfied in short pipe lines.

[3]Flow at constant temperature.

Table 3

(Use Absolute Pressures)

$\frac{P_E}{P_1}$	$\frac{P_2}{P_1}$	$\frac{P_E}{P_1}$	$\frac{P_2}{P_1}$	$\frac{P_E}{P_1}$	$\frac{P_2}{P_1}$
0.500	0	0.540	0.283	0.650	0.548
0.501	0.0447	0.542	0.290	0.655	0.557
0.502	0.0632	0.544	0.297	0.660	0.566
0.503	0.0775	0.546	0.303	0.665	0.574
0.504	0.0894	0.548	0.310	0.670	0.583
0.505	0.100	0.550	0.316	0.675	0.592
0.506	0.110	0.552	0.322	0.680	0.600
0.507	0.118	0.554	0.329	0.685	0.608
0.508	0.126	0.556	0.335	0.690	0.616
0.509	0.134	0.558	0.341	0.695	0.624
0.510	0.141	0.560	0.346	0.70	0.632
0.511	0.148	0.562	0.352	0.71	0.648
0.512	0.155	0.564	0.358	0.72	0.663
0.513	0.161	0.566	0.363	0.73	0.678
0.514	0.167	0.568	0.369	0.74	0.693
0.515	0.173	0.570	0.374	0.75	0.707
0.516	0.179	0.572	0.379	0.76	0.721
0.517	0.184	0.574	0.385	0.77	0.735
0.518	0.190	0.576	0.390	0.78	0.748
0.519	0.195	0.578	0.395	0.79	0.762
0.520	0.200	0.580	0.400	0.80	0.775
0.521	0.205	0.582	0.405	0.81	0.787
0.522	0.210	0.584	0.410	0.82	0.800
0.523	0.214	0.586	0.415	0.83	0.812
0.524	0.219	0.588	0.420	0.84	0.825
0.525	0.224	0.590	0.424	0.85	0.837
0.526	0.228	0.592	0.429	0.86	0.849
0.527	0.232	0.594	0.434	0.87	0.860
0.528	0.237	0.596	0.438	0.88	0.872
0.529	0.241	0.598	0.443	0.89	0.883
0.530	0.245	0.600	0.447	0.90	0.894
0.531	0.249	0.605	0.458	0.91	0.906
0.532	0.253	0.610	0.469	0.92	0.917
0.533	0.257	0.615	0.480	0.93	0.927
0.534	0.261	0.620	0.490	0.94	0.938
0.535	0.265	0.625	0.500	0.95	0.949
0.536	0.268	0.630	0.510	0.96	0.959
0.537	0.272	0.635	0.520	0.97	0.970
0.538	0.276	0.640	0.529	0.98	0.980
0.539	0.279	0.645	0.539	0.99	0.990
				1.00	1.00

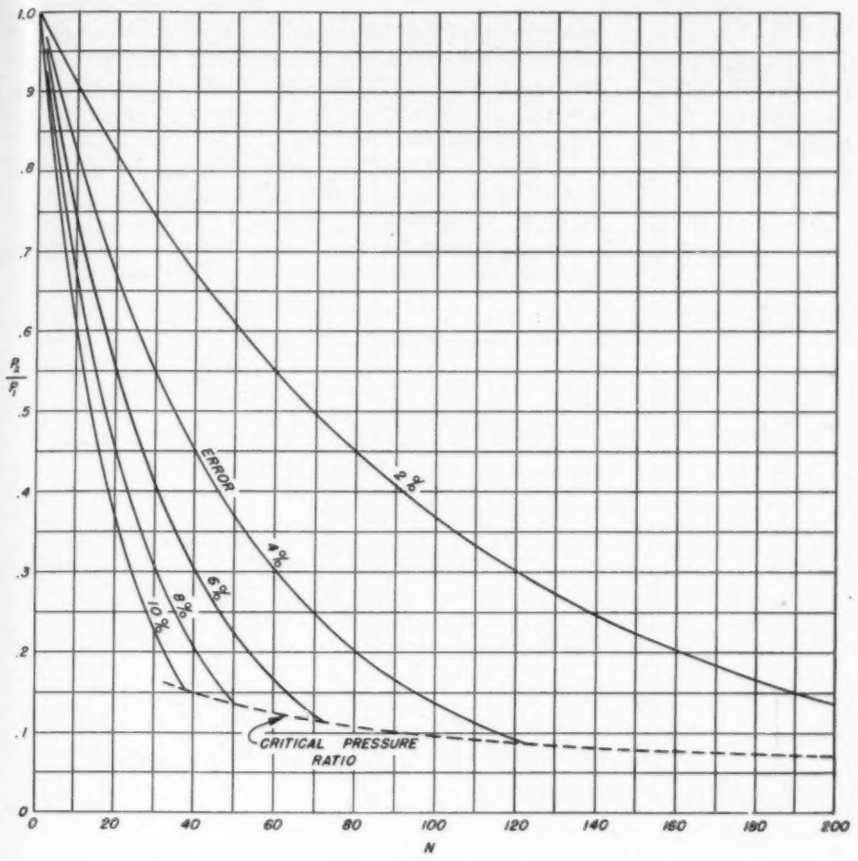


Fig. 3—Criterion for judging applicability of Formula 7. The dotted curve also gives the critical pressure ratios for various values of N

It is more probable that if a relatively large pressure drop takes place in a short pipe, the flow will be more nearly adiabatic.[4] When this is the case, methods based on adiabatic flow with friction should be used. Such methods are discussed in Schüle's "Technical Thermodynamics." For this reason, Formula 11 should be used only under the conditions where Fig. 3 shows that the line is long enough, or the pressure drop small enough, so that the error is negligible.

Critical Pressures

Although the subject matter discussed in this section perhaps does not belong in an article such as this, it is felt that some explanation is essential to prevent the misapplication of Formula 11 when large pressure drops are encountered in long pipe lines. The derivations of the various formulas used in this discussion are given in Appendix 5.

Although the principle of critical pressures and limiting flow through nozzles is well known, it is not so generally appreciated that limiting velocities and pressure drops are also encountered in pipe lines. Due to the expansion of the gas and the consequent increase in its specific volume, the velocity along the pipe line is continually increasing. When the velocity reaches some maximum point, the limiting flow is reached, no matter how much the pressure is decreased in the container into which the pipe is discharging. The flow will remain constant and will not increase beyond the maximum flow corresponding to the limiting velocity for the pipe line.

[4]Flow without any addition, or loss, of heat to the gas through the walls of the pipe.

Also, when the maximum flow is reached, the pressure at the outlet of the pipe will remain constant at some minimum value, which is known as the critical pressure. Even if the pressure in the container into which the pipe is discharging should be lower than the critical pressure, the pressure at the outlet of the pipe will not fall below this critical value. For long pipes, the value of the critical pressure depends only upon the value of N (see Formula 13) and can be read from the dotted curve of Fig. 3. For values of N larger than 100, the value of the critical pressure P_c is given very closely by Formula 14.

$$\frac{P_c}{P_1} = \frac{1}{\sqrt{N}} \quad \text{..(for } N > 100) \qquad [14]$$

If the pressure at the outlet of the pipe is equal to or lower than the critical pressure, Formula 15 gives the maximum weight of gas which can be delivered by the pipe line.

Consistent units:

$$W_M = A\frac{P_c}{P_1}\sqrt{g\,P_1\,d_1} \qquad [15]$$

Mixed units:

$$W_M = 28.36\,A\frac{P_c}{P_1}\sqrt{P_1\,d_1} \qquad [15a]$$

where

W_M = the maximum weight of fluid which can be discharged through the pipe line.

P_c = critical pressure at the outlet of the pipe.

A = cross-sectional area of the pipe (sq ft in Formula 15, and sq in. in Formula 15a).

Formula 15, with either the dotted curve of Fig. 3 or Formula 14, is sufficient to determine the maximum flow through a given pipe line. In determining the value N, it is first necessary to know the value of the friction factor f. Since, in this case, both the weight flowing and the pressure drop are unknown, it is necessary to assume some probable value of the friction factor f and solve for N. The critical pressure ratio, P_c/P_1, can then be found either from Fig. 3 or by Formula 14, depending on the value of N. With the critical pressure known,

Formula 15 can be used to find the maximum weight, W_M. After the weight W_M has thus been determined, Reynolds' number can be computed and the value of f found in Fig. 1. If this value of f checks the value first assumed, then the answer for W_M is correct. If it does not, a new value of f must be assumed and the problem solved again.

Sometimes a plot on graph paper is of help. The assumed values of f are plotted against the values of W_M found by Formula 15. This gives one curve. Then the actual values of f found in Fig. 1 are plotted against their corresponding values of W, thus giving a second curve. The point of intersection of the two curves gives the actual value of the maximum flow W_M and the friction factor f, which can then be used to determine the actual critical pressure.

As a rule, the outlet pressure will not be as low as the critical pressure for most conditions which arise in practice. Nevertheless, this condition does occasionally arise, and it is well to be aware of the existence of this phenomenon.

[Concluded]

Appendix 1

Derivation of the Modified Reynolds' Number, Rw

Take Formulas 1 and 4 of Table 1, and eliminate W between them. This will yield the following equation:

$$R_P = \sqrt{\frac{2g}{f}}\left[\frac{D}{u}\sqrt{prdD}\right] \quad \ldots\ldots [1]$$

Let

$$R_W = \frac{D}{u}\sqrt{prdD}. \quad \ldots\ldots [2]$$

Then

$$R_W = R_P\sqrt{\frac{f}{2g}} \quad \ldots\ldots [3]$$

By reading corresponding values of R_P and f from Curve A of Fig. 1, and then substituting into [3] above, the corresponding values of R_W for commercial pipe may be computed. Similarly, the values of R_W for smooth pipe may also be computed by using Curve B of Fig. 1.

Actually in plotting the auxiliary scales of Fig. 1, in order to insure as great a degree of accuracy as possible, the values of R_P and f were computed from the following equations:

The equation of Curve A as given by Drew, Koo and McAdams (Footnote 1) is:

$$f = 0.01228 + \frac{0.7544}{R^{0.38}} \quad \ldots\ldots [4]$$

The equation of Curve B is the Prandtl formula quoted by Eshbach:

$$\frac{1}{\sqrt{f}} = 2\log_{10} R\sqrt{f} - 0.8 \quad \ldots\ldots [5]$$

Incidentally, this equation gives results which are in very close agreement with the equation for smooth pipe quoted by Footnote 1, which is

$$f = 0.0056 + \frac{0.5}{R^{0.32}}$$

Derivation of the Modified Reynolds' Number, RD

Take Formulas 1 and 4 and eliminate D between them. This will yield the following equation:

$$R_P = \sqrt[8]{\frac{2g}{f}\left(\frac{4}{\pi}\right)^2}\left[\frac{W}{u}\sqrt[4]{\frac{prd}{W^2}}\right] \quad \ldots\ldots [6]$$

Let

$$R_D = \frac{W}{u}\sqrt[4]{\frac{prd}{W^2}} \quad \ldots\ldots [7]$$

Therefore,

$$R_D = R_P\sqrt[8]{\left(\frac{\pi}{4}\right)^2\frac{f}{2g}} \quad \ldots\ldots [8]$$

The value of R_D is also determined by using corresponding values of R_P and f as was done for R_W.

Streamline Flow

In determining the values of R_W and R_D for streamline flow, use was made of the following relationship, which is valid only for streamline flow:

$$f = \frac{64}{R_P} \quad \ldots\ldots [9]$$

This formula enables f to be eliminated directly from Formulas 3 and 8 of this appendix, yielding the following equations for the streamline scales only:

$$R_W = \frac{8}{\sqrt{2g}}R_P \quad \ldots\ldots [10]$$

$$R_D = R_P^{4/8}\sqrt[8]{\frac{\pi^2}{2g}} \quad \ldots\ldots [11]$$

Appendix 2

Derivation of Formula 7 of the Text

Formula 6 of the text can be reduced to Formula 7 by first writing it in the following form:

$$\left(P_1 - P_2\right)\frac{(P_1 + P_2)}{2} = \left(\frac{4}{\pi}\right)^2 f\frac{L}{D}\frac{P_1}{d_1}\frac{W^2}{2g}$$

Let $\dfrac{P_1 + P_2}{2} = P_a$, the arithmetical average pressure.

Also for isothermal expansion,

$$\frac{P_1}{d_1} = \frac{P_a}{d_a}$$

Making these substitutions, Formula 7 of the text is obtained.

Appendix 3

Derivation of Formula 12 of the Text

Dividing Formula 6 of the text by Formula 11 yields:

$$\frac{P_1^2 - P_2^2}{P_1 - P_E} = 2P_1$$

$$P_1^2 - P_2^2 = 2P_1^2\left(1 - \frac{P_E}{P_1}\right)$$

$$1 - \left(\frac{P_2}{P_1}\right)^2 = 2\left(1 - \frac{P_E}{P_1}\right)$$

$$\frac{P_2}{P_1} = \sqrt{2\left(\frac{P_E}{P_1}\right) - 1}$$

Appendix 4

Basis of Fig. 3

The complete form of Formula 6 as derived in Goodenough's "Principles of Thermodynamics" is substantially:

$$P_1^2 - P_2^2 = 2\left(\frac{4}{\pi}\right)^2 f\frac{L}{D}\frac{P_1}{d_1}\frac{W^2}{2g}\left(1 + \frac{2}{N}\log_e\frac{P_1}{P_2}\right) \quad \ldots\ldots [1]$$

Now, since (according to Formula 13 of the text) N varies directly with L, the length of the pipe line, it is evident that the term

$$\left(\frac{2}{N}\log_e\frac{P_1}{P_2}\right)$$

will become negligibly small as the length L increases.

It is evident that the error in neglecting the logarithmic term is

$$E = \frac{2}{N}\log_e\frac{P_1}{P_2} \quad \ldots\ldots [2]$$

where

E = percentage by which actual pressure drop exceeds pressure drop computed by Formula 6 of the text.

The chart of Fig. 3 was constructed by means of [2] above.

Appendix 5

Critical Pressures

Take Equation [1] of Appendix 4. Solve for W and differentiate with respect to $\dfrac{P_2}{P_1}$. Equating the differential so obtained to zero yields the following:

$$N\left(\frac{P_2}{P_1}\right)^2\left(1 + \frac{2}{N}\log_e\frac{P_1}{P_2}\right) = 1 - \frac{P_2}{P_1} \quad \ldots\ldots [1]$$

or

$$N = \left(\frac{P_1}{P_2}\right)^2 - \left(1 + \log_e\frac{P_1}{P_2}\right) \quad \ldots\ldots [2]$$

[Continued on page 720]

Practical Standards for Air Conditioning Calculations

By W. S. Bodinus*

AS explained last month, one of the most essential details in the correct procedure for calculating the engineering requirements of an air conditioning job is to prepare a complete survey including sketches, cross section, directions, etc. After this is completed the information contained in the survey is correlated to prepare the final engineering calculations, details of which have been explained in the previous articles.

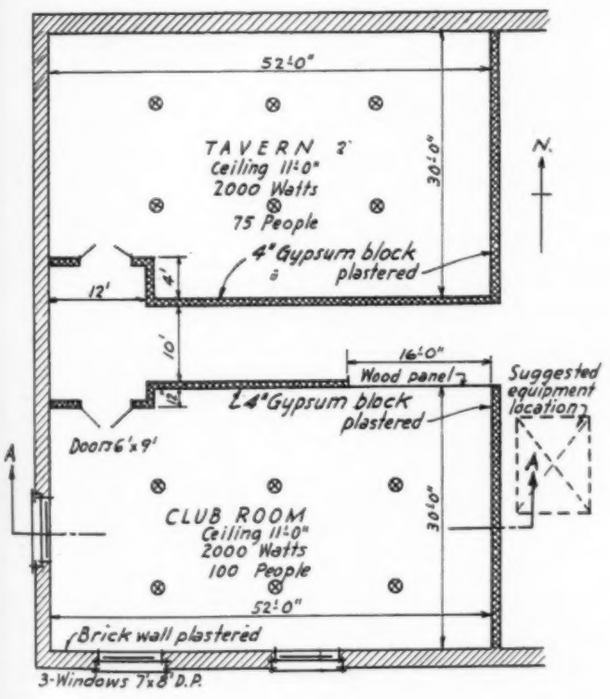
In concluding our discussion, let us consider the following illustrative example:

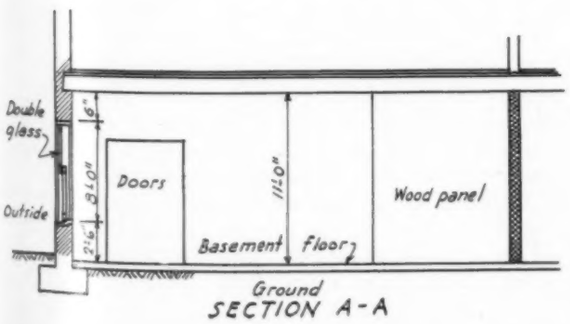
Summer outside temperature, dry bulb	95 F
Summer room temperature, dry bulb	80 F
Summer outside relative humidity	60%
Summer room relative humidity	50%
Outside temperature differential, (95-80)	15 F
Adjacent room temperature differential	10 F
Ground temperature differential	5 F
Winter outside temperature, dry bulb	—10 F
Winter room temperature, dry bulb	70 F
Winter room relative humidity	30%
Winter outside relative humidity	80%

The heat transfer coefficients in Btu per hr per sq ft per degree (U factors) may be calculated or taken from the data given in the A. S. H. V. E. *Guide*. For our illustrative problem, they are:

17 in. brick wall plastered	0.200
Gypsum block partitions	0.289
Floor	0.240
Inside wall wood	0.690
Double glass	0.500

Plan and section for problem





The areas of exposed surface are taken from dimensions marked on the survey plan and would be as follows (see sketches):

Room Data

Clubroom		
Brick wall area	(52 + 29) × 11 =	890 sq ft
Inside wall area	(30 + 37) × 11 =	740 sq ft
Door	6 × 9 =	54 sq ft
Wood panel	16 × 11 =	176 sq ft
Ceiling	(52 × 30) — (12) =	1548 sq ft
Floor		1548 sq ft
Glass	3 × 7 × 8 =	170 sq ft
Net brick wall	890 — 170 =	720 sq ft
Tavern		
Brick wall area	(52 + 26) × 11 =	860 sq ft
Inside wall	(52 + 4 + 30) × 11 =	950 sq ft
Ceiling	(30 × 52) — (4 × 12) = (1560)—(48) =	1512 sq ft
Floor		1512 sq ft
Door	6 × 9 =	54 sq ft

From this data typical calculations are made:

Heat Calculations

Clubroom	
Brick wall	720 × 0.20 × 15 = 2160 Btu per hr
Inside wall	740 × 0.289 × 10 = 2140 Btu per hr
Glass	170 × 0.50 × 15 = 1280 Btu per hr
Floor	1548 × 0.24 × 5 = 1860 Btu per hr
Ceiling	1548 × 0.24 × 10 = 3720 Btu per hr
Inside panel wall and door	230 × 0.69 × 10 = 1580 Btu per hr
Total	12,740 Btu per hr
Infiltration = two changes per hour, therefore, (Volume ÷ 56) × (t_2 — t_1) × 2 = (17,028 ÷ 56) × 15 × 2 =	9300 Btu per hr
Occupancy.....Sensible Heat = 100 × 220 =	22,000 Btu per hr
Latent Heat = 100 × 180 =	18,000 Btu per hr
Lights 2000 Watts × 3.4 =	6800 Btu per hr

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Part 7 of a series. Part 1 was published in May, pp. 281-284; Part 2 in June, pp. 367-368; Part 3 in July, pp. 415-417; Part 4 in August, pp. 488-491; Part 5 in September, pp. 553-554; and Part 6 in October, p. 632.

Tavern

Brick wall	860 ×	0.20 × 15 =	2580	Btu per hr
Inside wall	950 ×	0.289 × 10 =	2740	Btu per hr
Ceiling	1512 ×	0.24 × 10 =	3660	Btu per hr
Floor	1512 ×	0.24 × 5 =	1830	Btu per hr
Door	54 ×	0.69 × 10 =	374	Btu per hr
Total			11,184	Btu per hr
Infiltration				
	(16,632 ÷ 56) × 15 × 2 =		8950	Btu per hr
Occupancy—Sensible Heat				
	= 75 × 220 =		16,500	Btu per hr
Latent Heat				
	= 75 × 180 =		13,500	Btu per hr
Lights	2000 Watts × 3.4 =		6800	Btu per hr

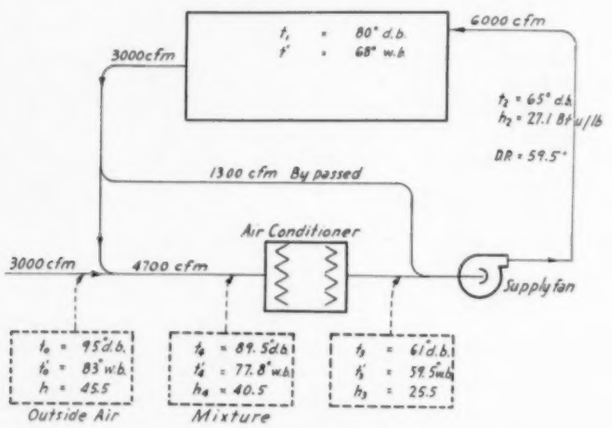
(*Note*—Above calculations by slide rule.)

The room total heat calculations are then tabulated. The quantity of air in cubic feet per minute is determined by using a temperature differential of 15 F (80—15), or 65 F entering air temperature, as in preceding articles of this series. Summing up:

Total Summer Heat Load

Heat Source	Btu per Hr		
	Clubroom	Tavern	Total
Conduction	12,740	11,184	23,924
Lights	6,800	6,800	13,600
Infiltration	9,300	8,950	18,250
Occupancy (Hs) (Sensible heat)	22,000	16,500	38,500
Total Hs (Sensible heat)	50,840	43,434	94,274
Occupancy Hl (Latent)	18,000	13,500	31,500
Grand total, Hs + Hl	68,840	56,934	125,774
Cfm designed	3,140	2,675	5,815
Cfm used	3,300	2,700	6,000

The total air supplied can be taken as 6000 cfm, which probably will fall within the capacity of a typical standard unitary air conditioning apparatus.



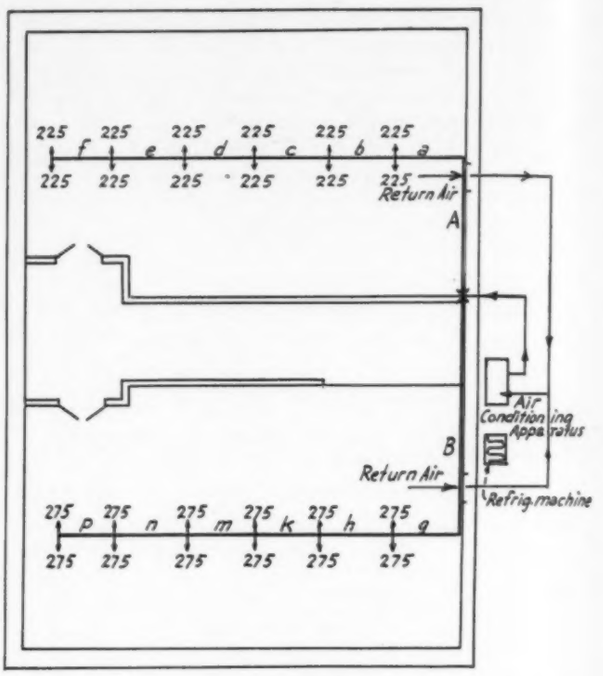
Bypass arrangement and air quantities

On the basis of using a bypass arrangement for summer cooling, which was discussed in an earlier article, the load works out to require 26 tons of refrigeration for both the tavern and the clubroom, using 3000 cfm of outside air and the balance recirculated air.

Cooling air	= 6000 cfm (total)
Bypass	= 1300 cfm
Outside air	= 3000 cfm
Cooled air	= 4700 cfm (outside and recirculated)

The details of the engineering design for ductwork and duct sizes are given in a most thorough manner in the chapter on air duct design in the latest issue of the *Guide*. The method is simple and sufficiently accurate for a small job such as that illustrated. The design hinges upon establishing a definite pressure drop per 100 ft of duct, such as 0.15 in. of water per 100 ft.

The total pressure loss of the ductwork is the sum of all the net pressure losses, to which must be added the pressure desired at the outlets and the pressure losses in the filters, cooling coils, and heating coils in order to obtain the total pressure against which the fan must deliver air.



Section (See Sketch)	Cfm	Equiv. Round Duct	Rectangular Duct Size	In. of Water Pressure Drop per 100 Ft	Length Ft	Net Pressure Loss
B	3300	21.0	32 x 12	0.15	25	0.0375
g	3300	21.0	32 x 12	0.15	8	0.012
h	2750	19.5	28 x 12	0.15	8	0.012
k	2200	18.0	24 x 12	0.15	8	0.012
m	1650	16.5	20 x 12	0.15	8	0.012
n	1100	13.8	13 x 12	0.15	8	0.012
p	550	10.6	12 x 8	0.15	8	0.012
A	2700	19.5	28 x 12	0.15	15	0.023
a	2700	19.5	28 x 12	0.15	8	0.012
b	2250	18.0	24 x 12	0.15	8	0.012
c	1800	17.0	20 x 12	0.15	8	0.012
d	1350	15.0	16 x 12	0.15	8	0.012
e	900	13.0	12 x 12	0.15	8	0.012
f	450	10.0	12 x 8	0.15	8	0.012

Duct layout and sizes

The engineering requirements now having been established, the price estimate and equipment specifications can be easily made. Major items for a job of the kind used in this example would be an air conditioning apparatus of the unitary type consisting of a fan section, cooling coil or spray section, filter section, bypass section and heater coil for winter tempering of air. Refrigerating equipment should preferably consist of two machines, one of 10 ton capacity and the other of 16 tons, cross connected and both designed to operate on air conditioning apparatus together or separately as the load requires. One large 26 ton machine could be used if capacity control were provided to adjust the compressor capacity to the air conditioning load.

[Concluded]

Heating·Piping
and Air Conditioning

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

JOURNAL SECTION

CONTENTS • NOVEMBER, 1937

Control of Body Heat Loss Through Radiant Means, by C. A. Mills and Cordelia Olge.. 697

Measuring Air Distribution and Grille Performance in Air Conditioning, by G. L. Tuve 700

The Inspiration of Society Membership..... 703

A.S.H.V.E. Annual Meeting in New York..... 704

Nominations for 1938..... 706

A.S.H.V.E. Research—A Page of News Notes and Comment, by Brewster S. Beach..... 708

Correlating Thermal Research..... 709

News of Local Chapters..... 710

Candidates for Membership..... 717

Candidates Elected 719

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Control of Body Heat Loss Through Radiant Means

By C. A. Mills, M.D., Ph.D.* (*MEMBER*), and Cordelia Olge, Ph.D.** (*NON-MEMBER*)
Cincinnati, Ohio

IN THIS article it is desired to present the results of certain preliminary studies which strongly indicate the feasibility of controlling body heat loss through radiant heat channels. These results appear to be striking and unequivocal in their significance, so much so that their early publication was deemed advisable in order that other investigators might aid in expanding this line of research. Briefly stated, efforts have been made to devise a conditioning system whereby body heat loss will be properly controlled, either in summer heat or winter cold, through radiant heat input or removal, quite independent of air humidity or air and wall temperatures.

Present *air* conditioning methods possess certain definitely unsatisfactory phases which are obviated in the new set-up. First and most important is the present necessity of maintaining sharp contrasts between indoor and outdoor air temperatures, both for winter heating and summer cooling. Respiratory infections, which form the great bulk of human illness in stormy regions, seem definitely related to storm changes in the outdoor atmosphere, particularly to sudden changes in temperature. There is much ground, therefore, for suspicion that such infections are also promoted by the necessity of facing sharp contrasts in air breathed on passing from a 75 F room into outdoor air at 0 F, or from outdoor air at 100 F into a room cooled from 80 to 85 F. The lesser contrast faced in summer heat may be just as effective in promoting respiratory infection, because of the lowered body resistance that is customary during hot weather.

The second objection to present methods lies in the necessity of warming or cooling the whole air mass and wall materials in order to produce body comfort. With air seepage and conduction loss from buildings, and with the human needs actually forming only a small part of the heating or cooling load, air conditioning would seem to be highly inefficient as a method of controlling body heat loss. More direct transmission of heat to or from the skin and clothing, without regard to air conditions, is possible only by radiant means. It therefore becomes important to know whether it is physiologically sound to control body heat loss in this manner.

Description of Experimental Rooms

Experimental rooms were set up within larger laboratory rooms and equipped to cover the desired conditions. In Room 1, (6 ft x 6 ft x 6½ ft inside measurements) with inside walls and ceiling constructed with rigid insulating board, air temperatures were maintained at 89 to 92 F and relative humidity at 60 to 70 per cent. Room 2 was similarly constructed, with air temperatures and humidity kept at the same level as in Room 1. However, it was lined throughout with aluminum foil glued to the wall board and contained six cold plates (20 in. by 42 in.) which were installed on two opposite side walls and connected to a condensing unit located outside the enclosure. These plates were kept at 32 to 40 F and acted as absorbing surfaces for radiant heat liberated within the room. They were exposed to the air and naturally imposed a heavy load on the air conditioning equipment by their cooling and dehumidifying action. In both rooms, however, air conditions were satisfactorily maintained at the desired temperature and humidity levels, and with not over 2° F difference in air temperature at points one foot from the ceiling and one foot from the floor. Room 3 (8 ft by 8 ft by 7 ft double walled steel, with 1 in. rock wool insulation) was also lined with aluminum foil and equipped with an air cooling unit connected to an outside compressor. In addition it had arrangements for an input of radiant heat from ordinary coil reflector units (400 watt total capacity). With no heaters operating, the air temperature could be reduced to 32 F, and with all heating and cooling capacity in use, air temperatures stabilized from 70 to 76 F, varying slightly with outside temperatures. Room 4 (similar in construction to Room 3) was air conditioned from a 66 to 70 F level by an ordinary room conditioning unit, with no radiant heat or cooling surface exposed within the room. In all four rooms adequate and similar ventilation was supplied by exhaust fans and proper air inlets, using inside laboratory air. Air conditioning within the rooms was accomplished by recirculating units placed inside the respective rooms.

Environmental Test Results

Effect on Human Subjects. Preliminary tests on human subjects indicated distinct discomfort in Room 1, with free perspiration and a smothering sensation. In Room 2, with identical air conditions, the stuffiness and smothering sensation were lacking, and adequate body cooling took place. In fact for a person to sit there working several hours, it became necessary to cover over part of the cold plates to prevent actual body chilling. One of the subjects, in caring for the mice during that part of the study, found it necessary to wear a woolen sweater in this room, even at 89 to 92 F air temperature and 60 to 70 per cent relative humidity. In Room 3, with the air at 32 F and no radiant heat on, body chilling was severe; but delightful comfort was achieved within a few minutes

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after the heaters were turned on, even though air temperatures were still below 40 F and the exhaled breath still visible. After all heater and cooler units had been in operation for days or weeks, this room was uncomfortably warm for human occupants within a half hour's time, at air temperatures of 70 to 76 F, no matter how lightly clothed. In Room 4, subjects were cool but comfortable when dressed in usual indoor winter clothing.

Effect on Mice. Human comfort for brief periods, however, is not a safe measure of environment effect. More general biologic effects after prolonged exposure must also be studied and taken into account. Accordingly, groups of healthy young white mice, which had been grown in the control room, were placed into the four test rooms. Every precaution was taken to have the four groups as similar as possible when placed in the rooms at three weeks of age. All were fed the same optimal diet which was used in previous work.[1] Weekly weighings were made on each individual mouse to get the growth curve, and the age at onset of fertility was obtained by frequent matings with adults of known fertility as soon as the mating age was reached. Each group consisted of 10 males and 20 females.

In Table 1 are given the results of these mouse observations. It is seen that fastest growth and earliest sexual development occurred in the group kept in Room 2; these animals developing even more rapidly than did those in Room 4 where best development had always previously prevailed. In Room 1 growth and development were suppressed by the moist heat, similarly as had been found in previous studies. In Room 3 a suppression of growth also took place, even though air temperatures were only 70 to 76 F and relative humidity low. Good health was maintained by the animals of all groups, with not a single death during the four months of observation. Accompanying the growth stimulation in Room 2 there was an earlier onset of fertility and the birth of litters about 1/5 larger in numbers than in Room 1 where growth suppression was accompanied by the birth of smaller litters of less viable young.

Table 1—Growth and Development of White Mice Under Variations in Ease of Body Heat Loss

	Room 1 Moist Heat	Room 2 Moist Heat-Radiant Cooling	Room 3 Cold Air-Radiant Heating	Room 4 Air Cooled
Average weight in grams of males when placed in rooms at 3 weeks of age.	11.1 grams	10.8 grams	10.8 grams	10.5 grams
Same at 10 weeks of age..	26.1 grams	29.3 grams	27.4 grams	28.3 grams
Same at 15 weeks of age..	28.3 grams	32.0 grams	29.4 grams	30.2 grams
Average age in days of females at delivery of first litter.....	63.9[a] days	55.1 days	56.3 days	56.2 days
Average number per litter.	6.5	7.7	7.6	7.7

[a]Half of the 20 females in this room have still shown no fertility at 16 weeks of age, even with repeated matings.

Whether judged by human comfort or mouse growth standards, it is evident that in Room 2 the depressing effects of moist warmth have been completely obviated by facilitating loss of body heat by radiation. With air at 89 to 92 F (practically summer dry skin temperature) and relative humidity of around 65 per cent, heat loss by conduction and convection can be only slight, and only by free perspiration and rapid air movement can evaporation be effective. The finding that body comfort and optimal animal growth can be secured in such a room, below the perspiration point, means that removal of practically all body heat *through radiant channels* is physiologically possible, and apparently quite desirable. The metabolic depression of Room 1, quite typical of tropical moist heat conditions, can be completely overcome by facilitating radiant heat loss alone, without any change in air temperatures or humidity. Just why the air of Room 2 should be so much more pleasant to breathe than that of Room 1 is not at present explainable, since they are apparently identical. The effective factor may perhaps concern radiant heat loss from the nasal mucosa directly.

The suppression of growth of the mice in Room 3 illustrates well the contention that it is the ease or difficulty of body heat loss which determines the metabolic or internal combustion level, and all the other vital functions thereto attached. No matter what the air temperature level, if the radiant heat load falling on the skin is so great as to make difficult the dissipation of this heat and that internally produced, then the body's response will be a reduction in internal combustion and a slowing down of its metabolism. Had facilities been available, it would have been desirable to run a fifth group of animals in Room 3 at air temperatures around 40 F, to show that optimal growth could have been safely produced by the right amount of radiant heat input, even though mice are very susceptible to body chilling. It is hoped that a series of tests can be run and the results reported soon.

Problems in Heat Physics

Certain interesting problems in heat physics have arisen during this work. Lack of suitable apparatus has prevented anything more than a cursory investigation of these physical aspects of the study. Unfortunately physical research seems never yet to have dealt with a number of radiant heat relationships that are here of fundamental importance. Aluminum foil, for instance, is known to be a poor emitter of heat and of high reflectivity; but does it reflect heat of all wave lengths equally well? For winter heating by radiant means, shorter wave length radiations from a hot surface are of concern, but in summer cooling the wave lengths dealt with are much greater. Nor is there available information relative to the absorption or emission of radiant heat from the different types of materials used in clothing and room furnishings.

Air and Wall Surface Temperatures

A few crude observations of air and surface temperatures were made in the test rooms, with results as indicated in Table 2. For air temperature determinations, ordinary mercury thermometers were used, after insulating against radiant heat by foil shields. Surface temperature measurements were made by a distant reading resistance thermometer.

The data of Table 2 afford an insight into the mechanism of radiant heat transfer that renders this

[1]Adaptation of Sexual Activity to Environmental Stimulation and Climatic Influence on the Growth of the Male Albino Mouse, by Cordelia Olge, (*American Journal of Physiology*, 1934, Vol. 107, pp. 628-640).

Table 2—Air and Surface Temperatures Within Rooms

Material	Temperatures, Deg F					
	Hot Room 1 (No Foil)	Hot Room 2 (Foil-lined)	Cold Room (Foil-lined) Radiant Heaters On or Off			
			Off for 3 Hours	On for 10 Min.	On 40 Min.	On 18 Hours
Air	90	90	50.0	58	66	76
Wall Surface	90	90	54.5	61	66	76
Wood Block	90	83	56.5	67	74	85
Iron Block	90	83	56.5	64	73	85
Cloth	90	83	.....	77	80	85
Trousers (on wearer)	91	85	.....	82	85	89

method of controlling body heat so effective. In Room 1 with no foil, all materials and the air assume a uniform temperature, making body heat loss by all avenues difficult. In Room 2, air and foil wall surfaces are at the same temperature as in Room 1, but all other materials assume definitely lower temperature levels, due to loss of heat by radiation to the cold plates. The thermometer hanging in this room exhibits a similar drop in temperature if its foil shield is removed so as to expose it to heat loss by radiation.

In Room 3, on the other hand, it is seen that air and foil wall surfaces tend to assume the same temperature soon after the radiant heaters are turned on, and that heat absorbing materials in the room (wood, iron, cloth, etc.) tend to have temperatures progressively higher than air or wall surface levels. And in this warming up process of heat absorbing materials, the most rapid temperature rise takes place in cloth. Preliminary observation indicates also that fall in temperature in the foil-lined hot room takes place more rapidly from cloth than from wood or iron surfaces. No detailed studies have yet been made as to differences in heat absorption or heat loss by different kinds of cloth. It will be of interest to see whether woolen and linen materials differ in this respect.

General Conclusions

In summary these preliminary findings indicate certain important points: (1) Human comfort and animal growth and development can be regulated, with what seems apparent safety, by control of body heat loss through radiant channels alone; (2) Practical feasibility of such radiant control lies in differences in radiant heat absorption and emission exhibited by various substances. Clothing materials rapidly radiate their heat to cold surfaces (if such be available) and fall to temperature levels well below those of surrounding hot air, thus encasing the body in a cooled capsule to which it can readily lose its internal heat. And in cold air, clothing readily absorbs radiant heat and forms a warm envelope around the body to slow the process of heat loss from the skin; (3) Foil wall surfaces act as efficient passive reflectors of radiant heat, although their temperatures are always maintained at air temperature level. This passive behavior of foil surfaces would seem largely to obviate the need for wall insulation, since the temperature of the wall surface is no longer of importance.

Certain problems in engineering and physics remain for solution. Foremost of these is the necessity of foil decoration that will not impair its heat-reflective property. Present physical tables of heat transparency for pigment materials which might be used in such decoration do not cover the longer wave-lengths such as are radiated from skin and clothing. It is known that certain lacquers may be applied without much alteration in the foil reflection of radiant heat, but even in this case there is no certainty that the lacquer might not absorb the longer skin radiations. A second problem, in engineering, lies in the development of means to isolate the cold plate from warm room air and moisture, so that air cooling and dehumidification may be avoided. Few known materials are transparent to heat waves from the skin, rock salt crystals being the only common material of high transparency.

Success in the preliminary studies here reported should go far to stimulate thorough investigation of the possibilities of adapting this scheme to the conditioning of indoor environments. It seems physiologically sound and to offer certain important advantages: (1) It makes possible elimination of marked contrasts between indoor and outside air; (2) The heating or cooling load will of necessity be far less than that of present conditioning methods, since the air and building mass no longer need so much warming or cooling; (3) Change to electric energy sources, reduction in insulation needs, and possible changes in type of construction—these need not be more than mentioned at this time.

Closest possible cooperation between engineers and physicists on the one hand, and medical and physiological scientists on the other, will be essential to the proper investigation of the possibilities residing in the conditioning scheme dealt with in this presentation of preliminary findings.

How Much Heat

Recommendations have been made to the National Bituminous Coal Commission for adoption of a non-technical uniform description of bituminous coals to protect consumers from misrepresentation and enable them to know exactly what type of coal they are buying.

The recommendations were made under authority by the Bituminous Coal Act of 1937, which established the office of the Consumers' Counsel to protect the interests of consumers. This Counsel would require bituminous producers to file with the Commission uniform descriptive specifications of their coal within six months after the Commission orders such action. Producers misrepresenting such specifications would be subject to the penalties set up in the Act for unfair trade practices. Uniform specifications, the Consumers' Counsel suggested, should be furnished to the consumer upon request. This would enable him to know what type of coal he is buying and how it is likely to suit his needs.

No additional burden would seem to be imposed upon operators by such a plan, because the measurable factors necessary for uniform specifications would undoubtedly have to be furnished, no matter what classification standards the Commission ultimately adopts.

This recommendation presents a plea for a standard language in describing coal, facilitates the use of specifications, and should be of prime interest to commercial and industrial buyers, retail dealers, etc., and, more important, to the home owner and individual consumers and consumer groups who wish to exercise their right of knowing the actual value of coal purchases.

Measuring Air Distribution and Grille Performance in Air Conditioning

By G. L. Tuve*, (*MEMBER*), Cleveland, O.

THE final measure of the success of a *comfort air conditioning* system must be the comfort of the occupant in the conditioned space. As long as a room is conditioned by moving treated air into it, the occupant will be concerned mainly with that part of the system which is located at or within the walls of the room. In other words, the outlet grilles or registers are, from the standpoint of the occupant, a most important part of the system. The engineer is apt to focus his attention upon the *internal works* of the system: the heating and cooling units, piping, ductwork, etc. But the occupant judges the engineer's results almost entirely upon the basis of the temperatures, air velocities and noise level in the rooms.

Specifications Without Meaning

A certain amount of technical and commercial data are available on air distribution in rooms, but in making use of these data there is one outstanding difficulty: *The specialists do not speak a common language.* For instance, consider the simple specification that *an* 18-*in. by* 8-*in. grille is to be used, with an outlet velocity of* 500 *fpm.* Does this mean that the air volume is to be 500 cfm, since the gross area of the grille is one square foot? Or does it mean that the velocity through the *free-open area* is to be 500 fpm? If the latter, the volume will depend on the grille design. Is the velocity to be measured with an anemometer, or possibly with a direct reading velocity meter? In either case, how is the instrument to be used, and by what area is the reading to be multiplied, in order to calculate the volume? If the grille is a wide-spreading deflecting type, how is the area to be measured, and how can an anemometer be used in front of a grille when the air emerges at an angle?

The difficulties are even greater in measuring the air stream in the room itself. Certain of the *Air Conditioning Codes* specify that: *There shall be no mechanically produced air velocity within the occupied zone, exceeding 50 linear feet per minute.* Since there is no specified method for making the velocity measurements, how can a contractor be responsible for an installation *according to the Code?* Another important question has to do with finding the edge or fringe of the *mechanically produced* air stream, in order to define the *throw* or *blow,* the *spread* and the *drop* of the primary air stream or air envelope in the room.

Experimental Work

In several experimental projects in the laboratories of the Case School of Applied Science, the performances of grilles and of air streams have been studied at some length. Many definite conclusions have been reached, one of them being that until there is some general agreement upon the methods of measuring the air and of expressing the grille performance, Code specifications and the commercial data will have only a hazy meaning. One of the test units used for these experimental studies is shown diagrammatically in Fig. 1, and by photograph in Fig. 2. This is a summer cooling unit with direct-expansion dichlorodifluoromethane coils, and with the grilles mounted in the side of a large vertical plenum chamber. Fig. 3 shows the refrigerating unit and the calibrated metering orifices to measure the air at the inlet end of the system. Air velocities were measured at the grille by an anemometer and a direct reading velocity meter, and in the room by anemometer, direct reading velocity meter, Kata-thermometer, indicating ribbons and smoke, (see Fig. 2.)

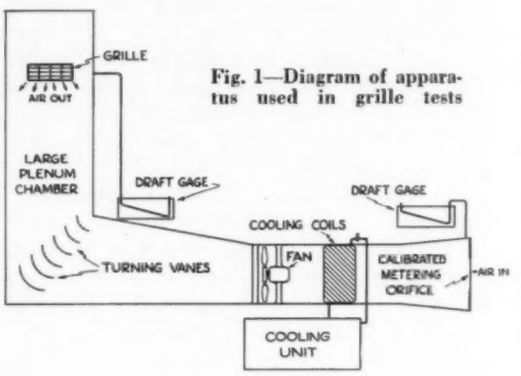

Fig. 1—Diagram of apparatus used in grille tests

In Table 1 an evaluation is made of these various methods of air measurement. The ratings in this table indicate that none of the six methods is satisfactory, but that a combination of two or three of them is necessary. No doubt improved methods and instruments can be

Table 1—Types of Low-Velocity Air Meters and Their Advantages

Advantages of Instrument	The Six Measuring Instruments					
	Direct Reading Velocity Meter	Anemometer (Rotating)	Ribbon Indicators	Kata-Thermometer	Smoke from Chloride or Tobacco	Smoke Bombs
Quick and easy to read	Good	Fair	Fair	Poor	Fair	Poor
Accurate at high velocities (to 1,500 fpm)	Good	Good	Poor	Poor	Poor	Poor
Sensitive at low velocities (under 100 fpm)	Good	Poor	Good	Good	Good	Fair
Does not disturb occupants of room	Good	Good	Fair	Good	Fair	Poor
Accurate calibration in feet per minute	Fair	Good	Poor	Fair	Poor	Poor
Shows outline of airstream in room	Fair	Poor	Good	Poor	Fair	Good
Gives average velocity over a period of time	Poor	Good	Poor	Fair	Poor	Poor

*Professor of Heat-Power Engrg., Case School of Applied Science.

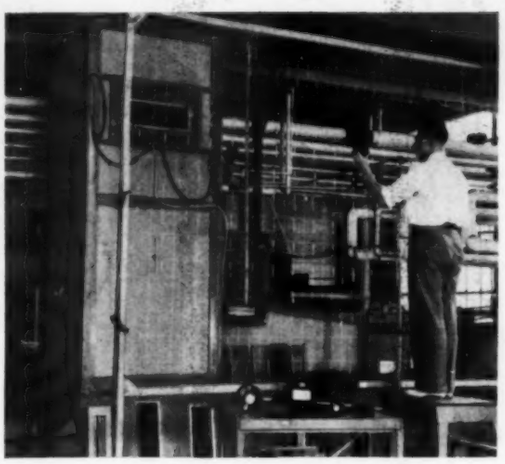

Fig. 2—Grille testing unit, showing observations by two of the six methods

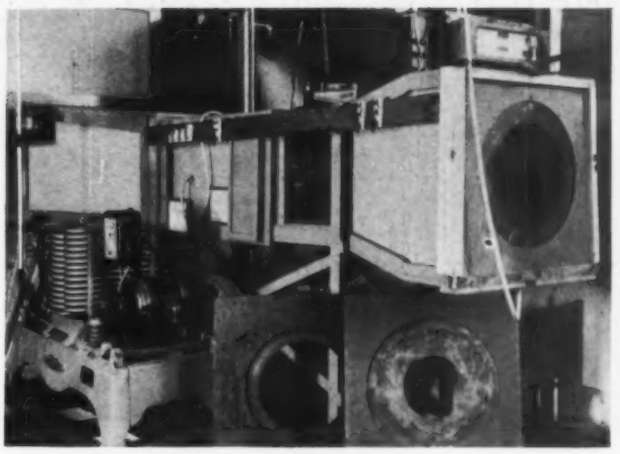

Fig. 3—Inlet of test unit, with air metering orifice

developed, but at present there is a decided lack of agreement on how the measurements are to be made.

The most common method of measurement of air velocity and quantity at the grille is by a rotating-vane anemometer. THE A. S. H. V. E. GUIDE 1937 (page 781) states that the anemometer should be held in contact with the grille, and that the area to be used with the anemometer reading, to obtain volume, should be the mean between the gross area and the free area. A number of engineers have objected to the use of this area rule for the typical straight-forward flow, low-resistance type of air conditioning grille. The author has tested at least half a dozen designs of typical low-resistance grilles, and has found in each case that the mean-area method gave incorrect results. Fig. 4 shows the results of a typical test, giving an error of approximately 20 per cent by using the mean area as specified in THE GUIDE, and very little error by using only the free area. The accuracy of these results was checked by using two anemometers, and calibrating both of them before and after the test. The grille was then moved to an entirely different set-up, using pitot tube traverse and pipe orifice for obtaining the volumes, and the results still agreed with those given in Fig. 4. Additional readings of air velocity at the grille face were taken with two different direct reading velocity meters. The velocities indicated by these instruments were 15 to 20 per cent higher than those obtained with the two anemometers.

Laws of Grille Performance

What are the laws and principles of grille and air-stream performance? THE GUIDE 1937 (page 352) gives some general statements, but more specific data are needed. Engineers who are interested in the problem should exchange ideas and information. In this spirit, the following test results are offered for criticism.

The experimental work at Case School of Applied Science[1] has been confined largely to the so-called low-resistance type of grille. The assembled steel-strip grille, with strips edgewise in the stream, does show a lower air resistance than most of the perforated or cast designs. The following conclusions from these experimental studies apply to low-resistance grilles of the more common shapes, (aspect ratio 2 to 5), with grille areas and air velocities such as would be used in rooms of moderate size:

1. An air stream from a straight-flow outlet grille assumes a natural included stream-angle of 15 to 25 deg, but this angle may be increased to 90 deg or even more by the use of suitable guide-vanes in the grille face.

2. The capacity of a low-resistance, straight-flow grille may be calculated by the simple orifice equation, $\text{Cfm} = C\ A\ \sqrt{2gh}$, on the basis that the free-open area $= A$, and a coefficient of discharge of about $0.77 = C$. (Probable accuracy $\pm$ 5 per cent.)

3. For a given grille, the maximum *throw* of the primary air stream in the room (if unconfined), varies approximately in direct proportion to outlet velocity and is independent of temperature.

4. Unless the aspect-ratio (ratio of width to height) is varied beyond the ordinary limits, its value has *very little* effect upon the maximum throw of the primary air stream in the room.

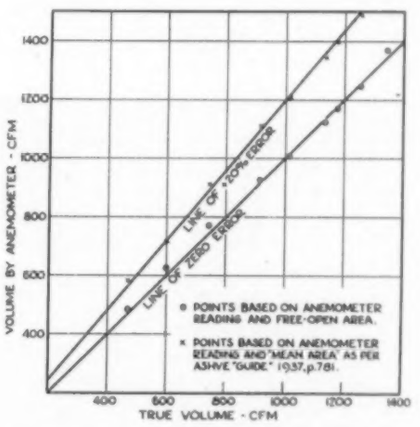
VOLUME BY ANEMOMETER - CFM
TRUE VOLUME - CFM
400
600
800
1000
1200
1400
LINE OF ±20% ERROR
LINE OF ZERO ERROR
• POINTS BASED ON ANEMOMETER READING AND FREE-OPEN AREA.
× POINTS BASED ON ANEMOMETER READING AND "MEAN AREA" AS PER ASHVE "GUIDE," 1937, p. 781.

Fig. 4—Typical anemometer test results on a grille of 135 sq in. free-open area

5. The maximum throw of a wide-angle or deflected stream is much less than that of a narrow-angle stream of the same total volume, and its *drop* (if cooled) is correspondingly less. Hence the drop of an air stream may be reduced by increasing its spread, *i.e.*, by using wide-angle deflecting or guide vanes.

6. For a straight-flow type of grille (0 deg deflection), the throw varies approximately as the square root of the free area.

[1]The author wishes to acknowledge with thanks the assistance of D. K. Wright and Prof. C. A. McKeeman, members of the staff of the Mechanical Engineering Department, Case School of Applied Science, in carrying out the experimental work on which this report is based.

7. The frictional resistance of a supply grille, *i.e.*, the total pressure at the upstream face, is not greatly increased by using deflecting vanes to give a wide-spreading stream. For a uniform fan-shaped stream of 90 deg total angle, the increased resistance is less than 50 per cent as compared with a straight-flow grille of the same nominal size and delivering the same volume of air.

8. When the air velocity at a given point in a room does not exceed 50 to 70 fpm, the temperature at that point will not deviate more than one or two degrees from the temperature at adjacent *still-air* locations on the same level.

It is at once admitted that the above laws do not completely define or describe grille and air-stream performance. The list is both approximate and incomplete. But it does give the engineer a reasonable answer to several of the most important questions, and its very incompleteness indicates the need for additional contributions.

The problem of standardizing the methods of measurement is the most pressing one, and in the author's opinion this should be undertaken at once by an appropriate Committee of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, and this Committee should be commissioned to carry out such research and correlation as may be necessary.

The Blackmore Family — Heating Engineers

The accompanying photograph shows four generations of the Blackmore family, three of whom are members of the A.S.H.V.E., and the youngest, born September 15, 1936, is a prospect.

J. J. Blackmore is a Charter Member of the Society and was granted Life Membership in 1931. He became secretary of the Society March 24, 1914, and served until February, 1915. He was a pioneer in the heating industry and was associated with J. L. Mott Iron Works up to the formation of United States Radiator Corporation in 1910, when he served as secretary of that organization. During the World War, he manufactured chemical equipment and since his retirement has devoted a great deal of time to world travel. He keeps in excellent physical condition with golf, which is his chief recreation and hobby. He tries to play three games a week and he has a record of having played on 650 different golf courses in various countries.

Of late he has been spending his winters in Florida and now at the age of 81 he is hale, hearty and enjoys life. When he is in New York he makes his home at the Engineers Club, 32 West 40th St.

F. H. Blackmore joined the Society in 1923 in St. Louis and was active in the local chapter. He is now located in Detroit and is a member of Michigan Chapter. He entered the heating field at West Newton, Pa., in 1901 with the United States Radiator and Boiler Co. and in 1910 was manager of the Corry, Pa., plant, when the United States Radiator Corp. was formed. Since that time he has been in charge of the West Newton, Pa., and the Edwardsville, Ill., plants of the company. Since 1928 he has been in the general office of the United States Radiator Corp. as manager of the manufacturing division.

J. J. Blackmore II was graduated from the University of Illinois in 1932 and in 1935 opened an office as manufacturers' representative in St. Louis and represents Bell & Gossett Co. and McDonnell & Miller in the eastern Missouri and southern Illinois territory. He resides in Edwardsville, Ill., and takes a great interest in outdoor activities, being scout master of a large boy scout troop. He joined the Society in February, 1937, and is a member of St. Louis Chapter.

J. J. Blackmore III was born September 15, 1936, and, while he has not announced his desire to join the Society, family custom indicates that he will become a member as soon as he is eligible.

This will carry out the advice of his great grandfather, who, at the Semi-Annual Meeting of the Society in 1916 at Detroit, said to the members present: "Don't you know that in giving up something for the general good you will get more real satisfaction than you would in making dollars? The fact that you have contributed something to help along the field of Heating and Ventilating Engineering will be a lasting source of satisfaction to anyone who accomplishes anything good. . . Each member should do all he can to induce those who are engaged in the industry to become members."

The Inspiration of Society Membership

Harry M. Hart, Chicago, Ill., has prepared the current article in cooperating with the plan of R. C. Bolsinger, chairman of the Society's Membership Committee, to present messages from a number of A.S.H.V.E. members who have been on the Rolls for a period of 25 to 40 years. Mr. Hart, who served the A.S.H.V.E. as president in 1916, is president of L. H. Prentice Co., and has addressed his message particularly To Those Who Contemplate Joining the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS:

Harry M. Hart

TO THOSE WHO CONTEMPLATE JOINING
THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

I joined the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS because I recognized the importance of its activities in the future development of the industry. As I had decided that my future welfare was going to depend on the Heating and Ventilating Industry, I felt it my duty to take an active part in any movement that had, as its objective, the solving of the many perplexing problems that confronted us at that time. It has been said, that "The closed hand cannot receive," and my experience through twenty-five years of active membership in the Society has proven this to be true. I gave what I could and what little bread I was able to cast upon the waters was returned many fold.

So I predict that those who join the Society for what they can get out of it will get very little.

If, however, they join with the firm determination of doing everything they can to help, they will be well repaid.

We never learn anything by performing the usual tasks that we know all about. It is only when we tackle something that we know little or nothing about that real education takes place. So if you think you want to learn more about the technical side of our industry, come on in and go to work. There is still much to be done and there always will be. If you are not willing to do this, just keep on subscribing to the various trade journals that you pile up on your desk for future reference, but which you never seem to have time to read.

Those, who read the articles originating in the Society but do not attend the Society meetings where these articles are presented, are missing the discussions that the papers create, which in my opinion, are often more interesting and instructive than the papers.

The local chapter meetings are a most important function of the Society's activities, providing as they do the opportunity for closer contact with our fellow members as well as a place where the various problems peculiar to particular locations may be presented for discussion and clarification.

I never could understand how anyone, who expects to make his livelihood from this industry, could afford not to be a member of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

A.S.H.V.E. Annual Meeting in New York

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January 24-28, 1938

DURING the week of January 24-28, 1938, New York will be the scene of the 44th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and the Fifth International Heating and Ventilating Exposition. In addition, the *American Society of Refrigerating Engineers* and the *National Warm Air Heating and Air Conditioning Association* will meet at the same time and the A. S. H. V. E. program provides for a joint session with each of these organizations.

Headquarters of the Society will be at the Hotel Biltmore so that A. S. H. V. E. members will be within a short distance of Grand Central Palace, where the Exposition will be held.

At the technical sessions which begin on Tuesday morning, January 25, thirteen papers will be presented on subjects of timely interest including district heating and steam jet refrigeration, air distribution, impurities in air, relation of skin temperatures to air conditions, control of air conditioning, water cooling and water conservation, physiological reactions to atmospheric conditions, office building air conditioning, effects of lighting on air conditioning, forced warm air heating, heat transfer through steel sash, moisture condensation in walls, etc.

These subjects are of widespread interest to Society members who attend and should provide for some lively discussions. Many of the papers represent contributions from the Society's Research Laboratory and cooperating institutions.

At the October 14 meeting of the Council provision was made for the attendance of official delegates from each of the Society's 25 Chapters and a Conference of these delegates is scheduled for Monday, January 24th, when a program of interesting discussions will be presented. The subjects to be discussed deal with local chapter problems and it is also expected that interesting comments will be heard on the effectiveness of the new Speakers Bureau Service recently inaugurated by the Council.

The entertainment features provide for a get-acquainted dinner and president's reception on Monday evening, a party at the French Casino on Tuesday, an inspection trip to the Lincoln Vehicular Tunnel and the annual banquet on January 27, as well as other interesting events.

The New York Chapter of the Society is planning to make the visit of A. S. H. V. E. members and guests to New York a memorable occasion and those responsible are the following members of the Committee on Arrangements: A. C. Buensod, *chairman;* Alfred Engle, *vice-chairman; Reception*—W. W. Timmis, *chairman; Banquet*—Russell Donnelly, *chairman; Finance*—F. E. W. Beebe, *chairman; Ladies*—H. W. Fiedler, *chairman; Publicity*—C. H. B. Hotchkiss, *chairman; Entertainment*—G. E. Olsen, *chairman;* and *Inspection Trips*—A. J. Offner, *chairman.*

Pres. W. E. Heibel, New York Chapter, recently appointed the Committee on Arrangements, which has started its work of providing entertainment for visiting Society members. Special attention will be given to the program for ladies, and a varied choice of entertainment features will permit them to spend many enjoyable hours during their stay in New York.

At the Heating and Ventilating Exposition, during the week of January 24, leading manufacturers will display heating, ventilating and air conditioning equipment. Winter heating of homes, public buildings, and factories, and air conditioning on a year 'round basis are themes which will be coordinated and amplified. Three floors of the Grand Central Palace will be used and advance indications are that the Exposition will be an outstanding success in terms of exhibits, exhibitors, and attendance.

The Society's booth at the Exposition will feature the work of the Research Laboratory and a picture of the broad service rendered to the profession through the work carried on at Pittsburgh and in cooperating institutions.

It is the hope of the Guide Publication Committee to have the *Heating, Ventilating and Air Conditioning Guide* 1938 ready for display at the Exposition. An information service on Society activities will be maintained at its booth for the benefit of visiting members.

Exhibitors manufacturing winter heating and conditioning systems are planning to show the advances which have been made in adaptability and control. Design trends will emphasize compactness and streamlining.

The Fifth International Heating and Ventilating Exposition is under the personal direction of Charles F. Roth, who has managed the previous expositions in this series, with headquarters at Grand Central Palace, New York.

Looking north across Central Park

Mid town section with Empire State Building in foreground

Tentative Program 44th Annual Meeting

Hotel Biltmore, New York

Monday—January 24

9:30 a. m.—Registration.
10:00 a. m.—Conference of Chapter Delegates.
12:30 p. m.—Council Meeting.
2:00 p. m.—Opening of Heating and Ventilating Exposition.
6:30 p. m.—Get-acquainted Dinner (Bowman Room).
President's Reception.

Tuesday—January 25

9:00 a. m.—Registration.
9:30 a. m.—First Session.
Greetings—W. E. Heibel, President, New York Chapter.
Response—President D. S. Boyden.
Reports of Committees.
Technical Paper—
Application of District Heating to Steam Jet Refrigeration, by A. R. Mumford and A. A. Markson.
Report of Tellers of Election.
12:00 noon—Heating and Ventilating Exposition.
2:00 p. m.—Joint Session with *National Warm Air Heating and Air Conditioning Association.*
Technical Paper—
Air Distribution from Side Wall Outlet, by D. W. Nelson and D. J. Stewart.
7:30 p. m.—French Casino Party.

Wednesday—January 26

9:30 a. m.—Technical Papers—
Relation of Body Changes to Air Changes, by Dr. R. W. Keeton.
Further Studies on Bacterial Control in Air Conditioning, by T. S. Carswell, J. D. Fleming and H. K. Nason.
Drop in Skin Temperature and Sense of Coolness with Various Air Conditions, by F. C. Houghten.
12:00 noon—Heating and Ventilating Exposition.
2:00 p. m.—Joint Session with *American Society of Refrigerating Engineers.*
Technical Papers—
Control of Air Conditioning in Large, Medium, and Small Buildings, by W. E. Zieber and S. F. Nichol.
Cooling Tower Equipment and Its Relation to Water Conservation, by S. I. Rottmayer.
Physiological Reactions and Sensations of Comfort under Various Atmospheric Conditions, by C.-E. A. Winslow, L. P. Herrington and A. P. Gagge.
6:30 p. m.—Past Presidents' Dinner.

Thursday—January 27

9:30 a. m.—Technical Papers—
Heating Effects of Artificial Lighting on Air Conditioning, by Walter Sturrock.
Comparative Analysis of Office Building Air Conditioning Systems, by J. R. Hertzler.
Heating and Ventilating the Lincoln Vehicular Tunnel, by C. W. Murdock.
12:00 noon—Heating and Ventilating Exposition.
2:00 p. m.—Inspection Trip Lincoln Vehicular Tunnel.
7:00 p. m.—Annual Banquet.

Friday—January 28

9:30 a. m.—Technical Papers—
Study of Methods of Control and Types of Registers as Affecting Temperature Variations in the Research Residence, by A. P. Kratz and S. Konzo.
Heat Transfer through Single and Double Glazed Steel Sash, by M. L. Carr, R. A. Miller, A. C. Byers and Leighton Orr.
Condensation of Moisture in Insulated Walls, by F. B. Rowley, A. B. Algren and C. E. Lund.
12:00 noon—Council Meeting.
12:00 noon—Heating and Ventilating Exposition.

Initiation Fees and Dues for 1938

The Council of the Society has voted the dues schedule for 1938, under the authority granted by Article B-IV, Sections 1 and 2 of the By-Laws, as follows:

Members and Associates	$18.00
Juniors	10.00
Students	7.50

Dues of new members will be pro-rated monthly, but where the amount is less than $5.00, THE GUIDE will not be furnished.

For 1938 all new members will pay Initiation Fees as follows:—

Members and Associates	$10.00
Juniors	5.00

The Initiation Fee must accompany all membership applications when filed.

NOMINATIONS FOR 1938

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1938, submits the following list of nominees:

For President:

E. H. GURNEY, Toronto, Ont., Can.

For First Vice-President:

J. F. MCINTIRE, Detroit, Mich.

For Second Vice-President:

F. E. GIESECKE, College Station, Tex.

For Treasurer:

A. J. OFFNER, New York, N. Y.

For Members of the Council:

Three-Year Term

N. D. ADAMS, Rochester, Minn.
A. P. KRATZ, Urbana, Ill.
J. H. WALKER, Detroit, Mich.
G. L. WIGGS, Montreal, Que., Can.

Respectfully submitted,

NOMINATING COMMITTEE,

N. D. ADAMS, *Chairman*
C. E. PRICE, *Secretary*

In accordance with the provisions of the Amended Constitution, as given, ballots containing the names of the above candidates will soon be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. B-VIII—Section 10. The Nominating Committee shall consist of one (1) member eligible to vote designated by each Chapter, or his alternate also appointed by the Chapter. The Secretary of each Chapter shall certify to the Secretary of the Society on or before January first the names of the member and alternate selected.

The Committee shall meet at the Annual Meeting of the Society at the call of the Secretary of the Society and shall effect its own organization and elect its own Chairman. At the Semi-Annual Meeting of the Society, if possible, the Nominating Committee shall select the nominees for the ensuing year for the offices of President, First Vice-President, Second Vice-President, Treasurer, and four (4) members of the Council. In any event the names of the nominees shall be certified to the Secretary of the Society before September twentieth, with the written consent of each nominee to fill the office for which he has been selected and their names with the offices to which they have been nominated shall be published in the October issue of the JOURNAL.

Art. B-IX—Section 2. The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election*. The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, adopted at the January, 1919, Meeting, and amended January, 1933, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1938:

Three-Year Term

M. K. FAHNESTOCK, Urbana, Ill.
W. L. FLEISHER, New York, N. Y.
R. J. TENKONOHY, St. Louis, Mo.
T. H. URDAHL, Washington, D. C.
B. M. WOODS, Berkeley, Calif.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

ARTICLE II—ORGANIZATION

Section 1. *Committee on Research*—There shall be a standing committee known as the Committee on Research, consisting of fifteen (15) members each serving for three (3) years and five (5) retiring each year. The outgoing Chairman if serving in that capacity during the last year of his three (3) year term on the Committee shall without election become an additional member of the Committee on Research for one (1) year.

(*a*) The Council shall nominate previous to July first of each year five (5) members to fill the vacancies of those retiring at the next Annual Meeting.

(*b*) The nominations made by the Council shall be published in the October issue of the Society's JOURNAL.

(*c*) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(*d*) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-laws and Rules.

(*e*) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

Pittsburgh Experiment Station of the U. S. Bureau of Mines where the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS *is located*

COMMITTEE ON RESEARCH

W. A. DANIELSON, *Chairman;* W. L. FLEISHER, *Vice-Chairman;* F. C. HOUGHTEN, *Director;* DR. A. C. WILLARD, *Technical Adviser;* A. C. FIELDNER, *Ex-Officio Member. One year:* C. A. DUNHAM, W. L. FLEISHER, ELLIOTT HARRINGTON, A. P. KRATZ, H. C. MURPHY. *Two Years:* W. A. DANIELSON, C. E. LEWIS, D. W. NELSON, C. TASKER, C.-E. A. WINSLOW, *Three Years:* H. E. ADAMS, A. E. STACEY, G. L. TUVE, J. H. VAN ALSBURG, J. H. WALKER.

Executive Committee: W. A. Danielson, *Chairman;* W. L. Fleisher, J. H. Walker.

Technical Advisory Committees

Committee on Air Cleaning—IP-4: H. C. Murphy,* *Chairman;* M. I. Dorfan, C. E. Lewis,* S. R. Lewis, G. W. Penney, A. L. Simison, W. O. Vedder.

Committee on Air Conditioning Requirements of Glass—IF-18: M. L. Carr, *Chairman;* F. L. Bishop, A. N. Finn, E. H. Hobbie, R. J. Lillibridge, R. A. Miller, F. W. Parkinson, W. C. Randall, L. T. Sherwood, J. T. Staples, C. Tasker,* G. B. Watkins, F. C. Weinert.

Committee on Air Distribution—IP-21: Ernest Szekely, *Chairman;* S. H. Downs, M. K. Fahnestock, F. J. Kurth, D. W. Nelson,* C. H. Randolph, J. E. Schoen, G. L. Tuve,* J. H. Van Alsburg.*

Committee on Air Friction—IP-6: J. H. Van Alsburg,* *Chairman;* C. A. Booth, S. H. Downs, C. M. Humphreys, R. D. Madison, L. B. Miller, L. G. Miller.

Committee on Atmospheric Impurities and Resulting Safety and Health Requirements—IP-26: Theodore Hatch, *Chairman;* J. J. Bloomfield, C. A. Booth, Philip Drinker, Dr. Leonard Greenburg, Elliott Harrington,* H. B. Meller.

Committee on Climate and Air Conditioning—C-24: Dr. C. A. Mills, *Chairman;* Major G. C. Dunham, James Govan, Dr. W. J. McConnell, C. F. Neergaard, Dr. F. M. Pottenger, Jr., E. L. Weber, Prof. C.-E. A. Winslow.*

Committee on Comfort Air Conditioning—OH-22: C. Tasker,* *Chairman;* A. E. Beals, F. R. Bichowsky, Thomas Chester, F. E. Giesecke, Elliott Harrington,* R. E. Keyes, A. B. Newton, C. P. Yaglou.

Committee on Corrosion in Air Conditioning Equipment—IF-14: A. E. Stacey, Jr.,* *Chairman;* A. F. L. Anderson, M. L. Diver, F. L. LaQue, C. E. Lewis,* R. M. Palmer, F. N. Speller, C. M. Sterne, R. T. Thornton, J. H. Young.

Committee on Corrosion in Steam Systems—IF-2: J. H. Walker,* *Chairman;* W. H. Driscoll, C. A. Dunham,* L. B. Miller, R. R. Seeber, F. N. Speller, C. M. Sterne.

Committee on Effect of Water on Roofs—IF-29: A. B. Snavely, *Chairman;* M. R. Beasley, J. B. Griffiths, Elliott Harrington,* E. H. Hyde, W. L. Murray, E. R. Queer, C. S. Reeve, E. T. Selig, Jr.

Committee on General Air Conditioning Comfort Requirements—OH-5: C. P. Yaglou, *Chairman;* J. J. Aeberly, R. R. Sayers, C.-E. A. Winslow.*

Committee on Heat Requirements of Buildings—IF-8: O. W Armspach, *Chairman:* P. D. Close, W. H. Driscoll, H. M. Hart, V. W. Hunter, H. H. Mather, E. C. Rack, F. B. Rowley, R. J. J. Tennant, J. H. Walker.*

Committee on Heat Transfer of Finned Tubes with Forced Air Circulation—IP-10: F. B. Rowley, *Chairman;* H. F. Hutzel, R. H. Norris, C. H. Randolph, W. E. Stark, G. L. Tuve,* C. F. Wood.

Committee on Insulation—IF-23: L. A. Harding, *Chairman;* E. A. Allcut, H. C. Bates, H. C. Dickinson, J. D. Edwards, E. C. Lloyd, W. E. McMullen, R. T. Miller, E. R. Queer, T. S. Rogers, F. B. Rowley, W. S. Steele, C. Tasker,* B. Townshend, G. B. Wilkes.

Committee on Intermittent Heating—IP-20: E. K. Campbell, *Chairman;* W. L. Cassell, Prof. E. F. Dawson, N. W. Downes, F. E. Giesecke, J. M. Robertson, J. H. Kitchen, Prof. A. H. Sluss, G. L. Tuve.*

Committee on Psychrometry—C-11: F. R. Bichowsky, *Chairman;* C. A. Bulkeley, J. A. Goff, Dr. E. V. Hill, F. G. Keyes, A. P. Kratz,* W. M. Sawdon.

Committee on Radiation with Gravity Air Circulation—IP-9: M. K. Fahnestock, *Chairman;* B. C. Benson, H. F. Hutzel, J. P. Magos, J. W. McElgin, J. F. McIntire, D. W. Nelson,* R. N. Trane, T. A. Novotney.

Committee on Relation of Body Changes to Air Changes—OH-3: Dr. E. V. Hill, *Chairman;* N. D. Adams, J. J. Aeberly, John Howatt, A. P. Kratz,* P. J. Marschall, V. L. Sherman.

Committee on Sound Control—IF-1: J. S. Parkinson, *Chairman;* C. M. Ashley, G. F. Drake, V. O. Knudsen, R. F. Norris, C. H. Randolph, J. P. Reis, A. E. Stacey,* G. T. Stanton, F. R. Watson.

Committee on Summer Air Conditioning for Residences—IP-7: M. K. Fahnestock, *Chairman;* E. A. Brandt, John Everetts, Jr., Elliott Harrington,* H. F. Hutzel, E. D. Milener, K. W. Miller, E. B. Newill, F. G. Sedgwick, J. H. Walker.*

Committee on Transportation Air Conditioning—C-12: L. E. Miller, *Chairman;* T. R. Crowder, F. B. Rowley, A. E. Stacey, Jr.,* L. W. Wallace.

Committee on Treatment of Air with Electricity—C-17: Prof. C.-E. A. Winslow,* *Chairman;* R. D. Bennett, W. H. Carrier, L. W. Chubb, Major W. D. Fleming, R. F. James, L. R. Koller, Dr. C. A. Mills, Prof. E. B. Phelps, Prof. G. R. Wait, Prof. W. T. Wells.

Committee on Weather Design Conditions—IF-31: W. E. Stark, *Chairman;* E. W. Goodwin, A. C. Grant, J. H. Kincer, A. P. Kratz,* L. S. Ourusoff.

*Member of Committee on Research.

A. S. H. V. E. RESEARCH

A Page of News Notes and Comment

By **Brewster S. Beach***

RESEARCH PROBLEMS DISCUSSED AT A. S. H. V. E. COUNCIL MEETING

J. H. Van Alsburg, Chairman Committee on Air Friction

Research problems came in for a major share of attention at the A.S.H.V.E. Council meeting in Philadelphia last month. F. C. Houghten, Director of the laboratory, reported some twenty projects under active study in Pittsburgh and with cooperative agencies. Particular importance was attached to the current work of the technical committee on air friction in ducts, which it was brought out at the meeting, is fundamental to the entire air conditioning industry. Additional funds were made available by the Council for intensifying this work.

While much remains to be done, preliminary data based on the testing of round, square and rectangular ducts indicate less frictional resistance to air flow in smaller ducts than previous data had suggested. The tests so far disclosed point to interesting possibilities for the use of smaller ducts in air conditioning systems.

Importance of Friction Studies

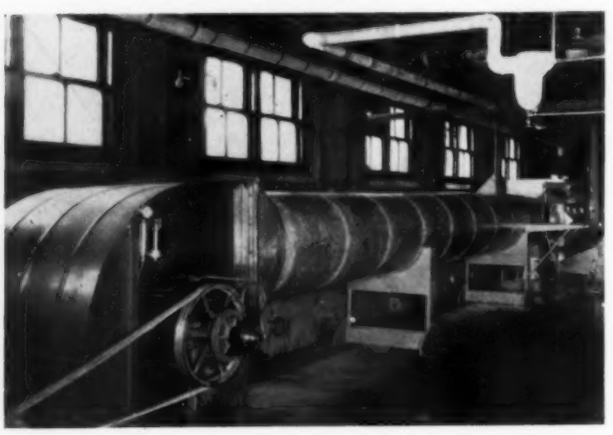
As was pointed out by W. A. Danielson, Chairman of the Committee on Research, this study is related directly to the cost and efficiency of duct systems in air conditioning which constitute a considerable percentage of the cost of an entire plant. If the trends disclosed in the preliminary investigations which have been completed at Pittsburgh are borne out by further tests on a greater variety of duct sizes, the industry may expect to see important changes in duct practice and resulting economies to the user, it was stated. Chairman of the Committee on Air Friction is J. H. Van Alsburg of Chicago and the members are: C. A. Booth, S. H. Downs, C. M. Humphreys, R. D. Madison, L. B. Miller and L. G. Miller.

F. C. Houghten Laboratory Director

Mr. Houghten reported to the Council on the trends shown by the data secured in tests among office workers in Minneapolis to determine their comfort reaction to summer air conditioning. These tests represent the first time that the comfort reaction of subjects, in their regular occupations as distinguished from those tested under purely laboratory standards, have been studied.

Indications are that the feeling of comfort among the 250 workers involved in this investigation is more pronounced at effective temperatures somewhat lower than were shown in previous laboratory tests. During the next few months, the large amount of data collected in Minneapolis will be thoroughly digested and a paper prepared for presentation at the next annual meeting.

Among other subjects discussed by Mr. Houghten were the investigations being carried on to determine the physiological effect of drafts and the work of the Committee on Air Cleaning Devices. Mr. Houghten reviewed the program mapped out by the Committee studying the insulation effect of various kinds of glass used in building construction and steps being taken by the laboratory to cooperate with the University of Pittsburgh and local hospital authorities in a further study of fever therapy by conditioned air.



Test set-up for studying air friction in ducts

EXECUTIVE COMMITTEE MEETS

Following last month's Council meeting, a meeting of the Executive Committee of the Committee on Research was held in Philadelphia to discuss plans for operations next year. It was the feeling of the committee as voiced by J. H. Walker that manufacturers, trade associations and other organizations within or allied to the air conditioning industry can be interested in supporting the society's research program on the basis of specific projects in which certain groups had a vital stake.

Chairman Danielson is communicating with the chairmen of the various technical committees requesting an outline of their proposed work in 1938 and the names of organizations whose direct interest in certain studies would warrant their being invited to contribute funds.

W. L. Fleisher called attention to the need for further study of the broad aspects of air conditioning in its relation to the control of disease as the basis of a comprehensive program which could be put before social service, medical or public health foundations.

A. R. Mumford has accepted the chairmanship of the technical committee on Corrosion in Steam Heating Systems, in a reorganization of this committee announced by Chairman Danielson. Mr. Mumford is an official of the New York Steam Corp.

*Director, Information Service, Committee on Research.

Correlating Thermal Research

As a part of the efforts of the A. S. H. V. E. Research Laboratory to correlate research in thermal engineering carried on by the many institutions engaged in such work, and to disseminate the published results of such studies together with other reports of progress in the field, and in order to make this information available to the membership of the Society, there will be published monthly on this page a limited number of brief abstracts of articles which it is believed will be of interest to all concerned. For more complete lists address the Librarian, A. S. H. V. E. Research Laboratory, U. S. Bureau of Mines Experiment Station, Pittsburgh, Pa.

F. C. Houghten, *Director*.

W. A. Danielson, *Chairman*.
COMMITTEE ON RESEARCH

• Ultra-violet Energy in Daylight, by M. Luckiesh and others. *Franklin Institute Journal* 223, pp. 699-714, June 1937. Report of a two years' investigation into the amount of ultra-violet energy in daylight and its variation during the day and with the season of year. As the tests were conducted mainly from an erythemal viewpoint, the energy at each wavelength was corrected for erythemal effect. The unit used is the E-viton.

• Transmission of Solar Radiation through Heat Absorbing Glass, by R. E. Estey and R. A. Miller. *Illuminating Engineering Society—Transactions,* vol. 30, no. 5, May 1935, pp. 403-410. Discussion pp. 427-432. Test methods and results on typical heat-absorbing glass; transmission quality of glass is completely characterized by its spectrophotometric curve; because of non-uniformity of sunlight and unreliability of weather, laboratory methods are suggested which yield results approximating average solar values, simple report form is illustrated.

• Methods of Measuring Visible and Total Energy Transmission of Heat Absorbing Glasses, by H. P. Gage. *Illuminating Engineering Society—Transactions,* vol. 30, no. 5, May, 1935, pp. 411-427. Recommendations as to limits of heat and light transmission of acceptable glass given on basis of good commercial practice; spectral characteristics for heat and light transmission made with artificial sources; measurement of heat and visible transmission. Proposed specification for tests of heat absorbing glass.

• Illumination of Structural Glass, by C. S. Woodside. *Illuminating Engineering Society—Transactions,* vol. 29, no. 10, Dec. 1934, pp. 878-893. Review of developments leading up to production of modern structural glass; characteristics of such glass with reference to insulation, obscuration and diffusion; problems involved in illumination of glassbricks, tiles and other architectural forms.

• Streamlining Mine Ventilation, by H. Landsberg. *Colliery Guardian,* vol. CLV, no. 4001, Sept. 3, 1937, pp. 419-420. Loss of head due to friction in crooked pathways in mine ventilation ducts. Diagram of streamlined ventilation duct bends and corners. Numerical value of power loss in acute and in rounded corners.

• Building Made of Mud, by Carey Holbrook. *Compressed Air Magazine,* vol. 42, no. 9, Sept. 1937, pp. 5407-5411. Description of adobe buildings, many of them several hundred years old. Method of making adobe bricks for houses, also use of "terrones" or blocks cut from grass sod. Building construction details.

• Residence and Small Office Air Conditioning, by G. B. Helmrich. *Mechanical Engineering,* vol. 59, no. 10, Oct. 1937, pp. 743-48. Summer cooling experimental work by the Detroit Edison Co. and its correlation with similar work in Research Residence at University of Illinois and in A.S.H.V.E. Research Laboratory. Discussion of comfort cooling with furnace and attic fans, ice cooling systems and mechanical cooling systems. Itemized cost of cooling a residence with ice and with electrical refrigeration shows electric refrigeration is cheaper.

• New Requirements, Use of Standards, Feature New York's Building Code, by George H. McCaffrey. *Industrial Standardization Monthly,* vol. 8, no. 9, Sept. 1937, pp. 230-234. Code effective Jan. 1, 1938. Code is characterized by the substitution of precise methods and by the placing of premiums upon the use of high grade technical skill and knowledge, in place of restricting the use of materials by large factors of safety.

• Note on a New Ocular Micrometer for Use in Dust Counting, by Richard T. Page. *U. S. Treasury Dept., Public Health Reports by Public Health Service,* vol. 52, no. 38, Sept. 17, 1937, pp. 1315-6. Description of technique of microscopic count of dust in impinger samples of air, similar to Whipple method for determining plankton concentration in drinking water. Diagram of ocular micrometer used by division of industrial hygiene of the U. S. Public Health Service.

• Concerning Tyndallometric Measurement of Dust Content in the Air and a New Dust Measuring Apparatus, by M. Berek and others, *translated* by Florence Feicht, Pittsburgh, 1937. 10 pages, typewritten, tables, diagrams. Communication from the physical laboratories of the Optical Works, E. Leitz, Wetzer. *Zeitschrift fur Instrumentenkunde,* 56, 1936, pp. 49-56.

• Industrial Exhaust Ventilation. Flow of Fluids, by John L. Alden. *Heating & Ventilating,* vol. 34, no. 9, Sept. 1937, pp. 39-45. Exhaust ventilation system used for dust collecting, fume removal and low-pressure conveying systems. Laws of flow of the conveying fluid.

• Heat Insulation, by E. I. Lloyd. *Colliery Engineering,* vol. 14, no. 163, Sept. 1937, pp. 309-311. Relative value of different kinds of insulation and heat loss due to inefficient use in a steam plant. Discussion of cork, diatomacious earth, aluminum foil, glass silk, magnesia. Thickness of magnesia insulation for buried pipe.

• Insulation and Its Relationship to Air Conditioning, by R. E. Backstrom. *Coal Heat,* vol. 32, no. 3, Sept. 1937, pp. 10, 12. Need for air conditioning for human comfort. Ideal air conditioning. Effect of insulation in saving fuel cost in winter and refrigerants in summer.

• The Coefficient of Heat Transfer for Vertical Surfaces in Still Air, by R. Ruedy. *Canadian Journal of Research,* vol. 15, no. 7. The coefficient of heat transfer for a vertical plane surface in still air, valid within the range of temperature found in buildings depends on the temperature and the height of the surface. Coefficient of heat loss with black body conditions. Heat loss from windows. Mathematical discussion.

• Corrosion in Water Tube Boilers, by David Brownlie. *The Fuel Economist,* London, vol. XII, no. 143, Aug. 1937, p. 384. Development of high duty boilers tends towards less steel per unit of evaporation; and the problem of corrosion becomes more significant. Prevention of corrosion;—add lime and soda ash to make-up water, deaerate the water by steam heating under vacuum and paint inside of boiler with graphite compound paint.

• Experiments with Fluid Friction in Roughened Pipes, by C. F. Colebrook and C. M. White. *Proceedings of the Royal Society, Series A Math. and Physics Sciences,* no. 906, Vol. 161, Aug. 3, 1937, pp. 367-381. Nikuradse, experimenting with flow through uniformly roughened pipes found comparatively abrupt transition from "smooth" law at slow speeds to "rough" law at high speeds. Other experimenters using surfaces of the nature of cast iron, wrought iron or galvanized steel, have obtained results which can only be explained by a much more gradual transition between the two resistance laws. These tests show that with non-uniform roughness, transition is gradual, and in extreme cases so gradual that the whole working range lies within the transition zone. Mathematical derivation of resistance formula. Resistance data for pipes with various surfaces.

NEWS OF LOCAL CHAPTERS

OFFICERS OF LOCAL CHAPTERS—1937

ATLANTA: *Organized,* 1937. *Headquarters,* Atlanta, Ga. *Meets,* First Tuesday. *President,* E. W. KLEIN, 152 Nassau St., N. W. *Secretary,* C. T. BAKER, 713 Glenn St., S. W.

CINCINNATI: *Organized,* 1932. *Headquarters,* Cincinnati, O. *Meets,* Second Tuesday in Month. *President,* I. B. HELBURN, 610 Chamber of Commerce Bldg. *Secretary,* H. E. SPROULL, 1005 American Bldg.

GOLDEN GATE: *Organized,* 1937. *Headquarters,* San Francisco, Calif. *Meets,* First Tuesday. *President,* B. M. WOODS, Univ. of Calif., Berkeley, Calif. *Secretary,* G. J. CUMMINGS, 113 Tenth St., Oakland, Calif.

ILLINOIS: *Organized* 1906. *Headquarters,* Chicago, Ill. *Meets,* Second Monday. *President,* S. I. ROTTMAYER, 407 S. Dearborn St. *Secretary,* C. E. PRICE, 6 N. Michigan Ave.

IOWA-NEBRASKA: *Organized,* 1937. *Headquarters,* Omaha, Neb. *President,* M. J. STEVENSON, 1643 South 20th St., Lincoln, Neb. *Secretary,* W. R. WHITE, 4339 Larimore Ave., Omaha, Neb.

KANSAS CITY: *Organized,* 1917. *Headquarters,* Kansas City, Mo. *Meets,* Second Monday in Month. *President,* A. H. SLUSS, 827 Mississippi Ave., Lawrence, Kan. *Secretary,* GUSTAV NOTTBERG, 914 Campbell St.

MANITOBA: *Organized,* 1935. *Headquarters,* Winnipeg. Man. *Meets,* Fourth Thursday. *President,* D. F. MICHIE, 492 Wardlaw Ave. *Secretary,* E. J. ARGUE, Ste. 23, Estelle Apts.

MASSACHUSETTS: *Organized,* 1912. *Headquarters,* Boston, Mass. *Meets,* Second Tuesday in Month. *President,* JAMES HOLT, Massachusetts Institute of Technology, Cambridge, Mass. *Secretary,* H. C. MOORE, 69 Massachusetts Ave., Cambridge, Mass.

MICHIGAN: *Organized,* 1916. *Headquarters,* Detroit, Mich. *Meets,* First Monday after the 10th of the Month. *President,* F. J. FEELY, 950 Trombley Rd., Grosse Pointe Pk. *Secretary,* G. H. TUTTLE, 2000 Second Ave.

WESTERN MICHIGAN: *Organized,* 1931. *Headquarters,* Grand Rapids, Mich. *Meets,* Second Monday in Month. *President,* W. W. BRADFIELD, 901 Michigan Trust Bldg. *Secretary,* S. W. TODD, JR., 309 Paris, S. E.

MINNESOTA: *Organized,* 1918. *Headquarters,* Minneapolis, Minn. *Meets,* Second Monday in Month. *President,* R. E. BACKSTROM, Room 1981, First Natl. Bank Bldg., St. Paul, Minn. *Secretary,* F. C. WINTERER, 836 Juno St., St. Paul, Minn.

MONTREAL. *Organized,* 1936. *Headquarters,* Montreal, Que. *Meets,* Third Monday. *President,* G. L. WIGGS, University Tower. *Secretary,* C. W. JOHNSON, 630 Dorchester St., W.

NEW YORK: *Organized,* 1911. *Headquarters,* New York, N. Y. *Meets,* Third Monday in Month. *President,* W. E. HEIBEL, 11 West 42nd St. *Secretary,* T. W. REYNOLDS, 100 Pinecrest Dr., Hastings-on-Hudson, N. Y.

WESTERN NEW YORK: *Organized,* 1919. *Headquarters,* Buffalo, N. Y. *Meets,* Second Monday in Month. *President,* B. C. CANDEE, 19 Tremont Ave., Kenmore, N. Y. *Secretary,* W. R. HEATH, 119 Wingate Ave.

NORTHERN OHIO: *Organized,* 1916. *Headquarters,* Cleveland, O. *Meets,* Second Thursday in Month. *President,* PHILIP COHEN, 401 East Ohio Gas Bldg. *Secretary,* C. A. MCKEEMAN, Case School of Applied Science.

OKLAHOMA: *Organized,* 1935. *Headquarters,* Oklahoma City, Okla. *Meets,* Second Monday. *President,* E. F. DAWSON, University of Oklahoma, Norman, Okla. *Secretary,* E. W. GRAY, Box 1498, Oklahoma City, Okla.

ONTARIO: *Organized,* 1922. *Headquarters,* Toronto, Ont. *Meets,* First Monday in Month. *President,* G. A. PLAYFAIR, 113 Simcoe St. *Secretary,* H. R. ROTH, 57 Bloor St. W.

PACIFIC NORTHWEST: *Organized,* 1928. *Headquarters,* Seattle, Wash. *Meets,* Second Tuesday in Month. *President,* W. W. COX, 326 Columbia St. *Secretary,* M. N. MUSGRAVE, 314-9th Ave., N.

PHILADELPHIA: *Organized,* 1916. *Headquarters,* Philadelphia, Pa. *Meets,* Second Thursday in Month. *President,* L. P. HYNES, 240 Cherry St. *Secretary,* C. B. EASTMAN, 530 Brookview Lane, Brookline, Upper Darby, Pa.

PITTSBURGH: *Organized,* 1919. *Headquarters,* Pittsburgh, Pa. *Meets,* Second Monday in Month. *President,* M. L. CARR, P. O. Box 1646. *Secretary,* T. F. ROCKWELL, Carnegie Inst. Tech.

ST. LOUIS: *Organized,* 1918. *Headquarters,* St. Louis, Mo. *Meets,* First Tuesday in Month. *President,* G. W. F. MYERS, 3947 W. Pine Blvd. *Secretary,* D. J. FAGIN, 1344 Woodruff Ave.

SOUTHERN CALIFORNIA: *Organized,* 1930. *Headquarters,* Los Angeles, Calif. *Meets,* Second Tuesday in Month. *President,* E. H. KENDALL, 1978 S. Los Angeles St. *Secretary,* J. F. PARK, 1234 South Grand.

TEXAS: *Organized,* 1936. *Headquarters,* College Station, Texas. *President,* R. F. TAYLOR, 909 Banker's Mortgage Bldg., Houston, Tex. *Secretary,* W. H. BADGETT, Texas Engrg. Experiment Station, College Station, Tex.

WASHINGTON, D. C.: *Organized,* 1935. *Headquarters,* Washington, D. C. *Meets,* Second Wednesday in Month. *President,* L. OURUSOFF, 411 Tenth St., N. W. *Secretary,* L. F. NORDINE, Room 203, 734 Jackson Pl., N. W.

WISCONSIN: *Organized,* 1922. *Headquarters,* Milwaukee, Wis. *Meets,* Third Monday in Month. *President,* J. H. VOLK, 1906 W. St. Paul Ave. *Secretary,* H. C. FRENTZEL, 3000 W. Montana St.

M. J. Stevenson
President

W. R. White
Secretary

F. L. Banner
Treasurer

Iowa-Nebraska Chapter Holds Organization Meeting

September 22, 1937. A meeting to organize an Iowa-Nebraska Chapter of the Society was held at the Hotel Fontenelle, Omaha. M. J. Stevenson called the assembly to order and briefly stated the purpose of bringing together those directly associated with the heating, ventilating and air conditioning industry, and cited some of the benefits derived from the formation of a local chapter.

A. V. Hutchinson, secretary of the A. S. H. V. E., was introduced by Mr. Stevenson and discussed the activities of local chapters in various parts of the country. He outlined the procedure to follow in organizing a local group and stated that the Iowa-Nebraska Chapter would be the twenty-fifth in the U. S.

During a general discussion regarding the time and place of holding meetings, Mr. Stevenson suggested that they be held alternately between Omaha and Des Moines, with one meeting a year at the Iowa State College at Ames and one at the University of Nebraska at Lincoln. After some discussion, it was tentatively decided to rotate the meetings between Omaha and Des Moines.

Officers were elected to serve temporarily as previously announced and President Stevenson appointed the following committees: *By-Laws Committee*—W. R. White, *chairman*, A. L. Walters, H. A. Sallander; *Membership Committee*—Henry Kleinkauf, *chairman*, F. L. Millard, W. V. Hogan, F. E. Prawl.

The annual rate of chapter dues was established and it was voted that the arrangements for the October program be left in charge of the officers.

Prof. C.-E. A. Winslow Addresses Ontario Chapter

October 12, 1937. Sixty-four members and guests of Ontario Chapter were present when the meeting was called to order in the Royal York Hotel, Toronto, following dinner.

Pres. G. A. Playfair appointed a committee consisting of H. S. Moore, Thomas McDonald, H. B. Jenney, W. R. Blackhall and W. P. Boddington to prepare a special program for the January meeting in honor of E. H. Gurney, 1st vice-president of the A. S. H. V. E.

The speaker of the evening was Prof. C.-E. A. Winslow, School of Public Health, Yale University, New Haven, Conn., who was presented by H. H. Angus. Professor Winslow's address on the Influence of Air Conditions on Human Health and Comfort proved to be very interesting and the discussion which followed was taken part in by a number of Ontario members.

O. L. Maddux extended a vote of thanks to Professor Winslow on behalf of the Ontario Chapter for his instructive talk before adjournment.

Pres. D. S. Boyden Visits Atlanta Chapter

October 11, 1937. A special meeting of Atlanta Chapter was held at the Atlanta Biltmore Hotel in honor of Col. D. S. Boyden, Boston, Mass., president of the American Society of Heating and Ventilating Engineers. A dinner at 6:00 p. m. was attended by Chapter members and friends, and at its conclusion President Boyden officially presented the charter, which was accepted by Pres. E. W. Klein.

An illustrated lecture was given by President Boyden on The Various Uses of District Steam for Heating Buildings, and in addition to A.S.H.V.E. members, many interested non-members were present, as well as some of the faculty of Georgia Tech and a group of students from the Applied Science Department of Tech Evening School.

During his sojourn in Atlanta, Colonel Boyden was well entertained. In the morning he was taken on an inspection trip to the steam heating system of the Techwood Housing Project by members of the Chapter and the chief engineer of the steam heating department of the Georgia Power Co. Following this he made a brief visit to Georgia Tech and later enjoyed a game of golf at the East Lake Country Club. President Boyden expressed himself as having had the opportunity of playing one of his most enjoyable games of golf, as he had the opportunity of playing on the No. 1 Course, made famous by Bobby Jones of Atlanta. The Colonel stated, off the record, however, that it was a "customer's game" until near the end of the last hole, whereupon L. F. Kent and C. C. Gray took him and his partner, Lewis Gordon, into camp. It seems, however, that this was compensated for by the fact that Colonel Boyden had the opportunity of renewing acquaintanceship with Bobby Jones, whom he had known at Harvard some years ago.

September 21, 1937. Secy. C. T. Baker reports that the Atlanta Chapter met in regular session at the Atlanta Biltmore Hotel with Pres. E. W. Klein presiding. The first order of business was the reading of the minutes of the organization meeting of the Chapter, which were approved.

Secretary Baker then read several communications from headquarters office regarding the newly created Speakers Bureau of the Society. After careful consideration of this matter, it was decided that it would be advisable for the Speakers Bureau to furnish two speakers each year during the months in which such speakers would be available. It was the consensus of opinion that the following subjects would be most timely: the present status of the comfort zone and its practical use and application in comfort cooling work; ventilation, including a definition and probable requirements of typical installations; effect of air conditioning on health.

With reference to the question of monthly meetings, it was unanimously agreed that such meetings should be held on the first Tuesday of each month at 8:00 p. m.

The visit of Pres. D. S. Boyden was discussed and it was decided to invite all of the local engineers, as well as those from outlying sections to attend the illustrated lecture to be given by Colonel Boyden. L. F. Kent was authorized to take charge of newspaper publicity.

President Klein presented the matter of a proposed engineers' club for Atlanta, intended primarily as a social adjunct to the regular engineering and technical society activities. It was stated by President Klein that the tentative plans being considered contemplated the arranging of a suitable place conveniently located to the hotel and restaurant section of the city which would be available to members.

An announcement was made regarding the October 4 meeting at the Ansley Roof Garden of the electrical engineers, when an illustrated lecture was given on Lightning and Its Effect on Transmission lines and Electrical Equipment Generally.

Western Michigan Members Hear Discussion of Sound

October 11, 1937. Pres. W. W. Bradfield called the meeting to order and the report of Secy. S. W. Todd, Jr., was read and approved. Society membership was invited of those guests who were actively interested in heating and ventilating, and it was suggested that meetings and programs be made public insofar as possible, to extend the interest in the subjects under discussion.

R. L. Davis was introduced by O. D. Marshall, chairman of the Program Committee, and gave an interesting and instructive talk on Sound Measurements and Related Practical Problems. With the aid of charts, he transposed sound measurement into standards of more familiar usage, explaining the differences, particularly with the rate of increase. In more general terms it was shown that sound density bears an important relationship to air conditioning; as for example, the relation of fan movement to human comfort.

Mr. Davis advocated the application of sound engineering in the preliminary drawings of buildings, rather than after the building's completion, when silencing or sound absorption is merely a corrective. He stated that more attention to fan size, or any such noise problem, and the expenditure of relatively little more frequently means the saving of considerable expenditures later required to correct or eradicate. Related problems of material in a room and room size, and the human element or

personality factor are important engineering details, according to Mr. Davis.

A splendid attendance was obtained and the Chapter looks forward to renewed and greater interest among its members.

Dr. C. A. Mills Addresses Michigan Chapter

October 11, 1937. The first meeting of the 1937-38 season of the Michigan Chapter was held at the Wardell Hotel with approximately 75 members and guests in attendance. Following dinner Pres. F. J. Feely asked for roll call and a report from all committee chairmen. J. H. Walker discussed Society activities for 1938.

President Feely then introduced the speaker of the evening, Dr. C. A. Mills, Professor of Experimental Medicine, College of Medicine, University of Cincinnati. Dr. Mills discussed the subject of Physiologic and Health Factors as Related to Air Conditioning and pointed out a definite relationship between human activity and climatic conditions. He described laboratory experiments conducted on radiant heating and cooling and cited an incident in one test room where the dry-bulb temperature was 92 deg and the relative humidity 70 per cent, and yet the air conditions were comfortable due to the presence of a radiant cooling panel on one wall.

After Dr. Mills completed his talk, an interesting discussion was held and among those taking part were Prof. F. J. Linsenmeyer, Dr. Simpson, Dr. Bailey, A. L. Sanford and Mr. Hubbard.

Secy. G. H. Tuttle reports that the meeting adjourned at 10:30 with everyone giving a rising vote of thanks to Dr. Mills.

Manitoba Chapter Plans for 1937-38

September 23, 1937. The fourteenth meeting of Manitoba Chapter was held at the Fort Garry Hotel, Winnipeg, at 6:15 p. m., and following the summer recess, activities were planned for the coming year.

Following the reading of the minutes of the previous meeting, the Nominating Committee nominated E. J. Argue, who was elected as secretary unanimously without a recorded vote, there being no other nominations. The new president, D. F. Michie, then gave his report to the Chapter, expressing his appreciation to the members for their confidence expressed by his election, and his pleasure in associating with the Society, and assurance of his full cooperation.

President Michie outlined the program for the forthcoming year, and reported that arrangements had been made by the Society to have F. B. Rowley address the Chapter on October 28 on the subject of The Influence of Building Construction on Air Conditioning.

Following a general discussion as to arrangements to be made for the October meeting, J. B. Steele, chairman of the Membership Committee, gave his report with the names of prospective new members, also suggesting that out of town members of the Society, and members in adjoining Provinces, should be sent notices of the forthcoming Chapter's meetings in Winnipeg.

In the absence of H. R. Eade, treasurer, Mr. Michie gave his report.

A letter from the Golden Gate Chapter, San Francisco, was read by President Michie expressing their good wishes to this Chapter, and their cordial invitation to visit them. Plans were also discussed for a visit to the Manitoba Chapter of the members of the Minnesota Chapter.

A general discussion followed in respect to the misunderstanding of the general public as to the correct meaning and use of the term *Air Conditioning*. It was thought that equipment manufacturers could continue to use this term, but might be persuaded to modify it if a generally accepted grading, or classification, were to be proposed and publicized by responsible parties. The following classification was suggested as a basis for discussion:

Function	*Descriptive Classification*
Heating	Single Stage Winter Air Conditioning
Humidifying	Single Stage Winter Air Conditioning
Heating and Humidifying	Two Stage Winter Air Conditioning
Heating, Humidifying, Circulating, Filtering	Three Stage Winter Air Conditioning
Cooling	Single Stage Summer Air Conditioning
Dehumidifying	Single Stage Summer Air Conditioning
Cooling and Dehumidifying	Two Stage Summer Air Conditioning
All functions, year around	Five Stage, or Complete Air Conditioning

J. B. Steele suggested that this discussion should be included in the minutes so that the idea might be passed on to the Society at large. The members present thought that no formal resolution should be framed until the subject had been more widely discussed.

In the absence of Mr. Argue, R. L. Kent acted as secretary and the meeting adjourned at 10:15 p.m.

Forced Warm Air Heating Subject of Pittsburgh Meeting

October 11, 1937. Vice-Pres. J. F. Collins, Jr., called to order the Pittsburgh Chapter meeting in the Downtown Y. M. C. A., with 35 members and guests present.

Minutes of the September meeting were read and approved, and a report of Treas. J. E. McLean was presented. It was announced that the Program Committee had arranged to have R. A. Sherman of Battelle Memorial Institute present at the November meeting. Mr. Collins announced the appointment of the Nominating Committee as follows: R. J. J. Tennant, *chairman,* F. C. McIntosh, P. A. Edwards; and stated that J. A. Strauch, *chairman,* and R. J. J. Tennant were in charge of arrangements for the December meeting.

It was voted that the Program Committee should be authorized to arrange for future meetings to be held at Stouffer's Restaurant.

Prof. C. M. Humphreys was requested to re-state to the Council at its October meeting the invitation of the Pittsburgh Chapter to hold the 1939 Annual Meeting in Pittsburgh.

F. A. Kitchen, president of American Warming and Ventilating Co., Cleveland, was introduced and spoke on Forced Warm Air Heating. Mr. Kitchen discussed the thermal properties of air and in his talk he described duct systems, stressing the temperature drop in ducts, different types of furnaces, grille types and location, and temperature control. Mr. Kitchen's address proved very interesting to Pittsburgh members and was followed by considerable discussion.

According to Secretary T. F. Rockwell, the meeting adjourned at 9:40 p. m.

Influence of Air Conditioning Upon Health Discussed at Illinois Meeting

October 11, 1937. The first Illinois Chapter meeting of the new 1937-1938 season was held on Monday evening at the Brevoort Hotel, Chicago. Eighty-six were present at dinner and 20 others came later to attend the business session.

The meeting was called to order by Pres. L. S. Ries. He introduced several prominent members of the medical profession who were present and then proceeded to the business of the meeting.

The secretary read the minutes of the last Chapter meeting in May, as well as a report of the Semi-Annual Meeting of the A.S.H.V.E. at Swampscott, Mass., in June.

J. R. Vernon reported on the work of the committee which led to choosing the Brevoort Hotel as the Chapter's meeting headquarters. J. J. Aeberly reported briefly on the activities of the National Council of which he is a member.

E. M. Mittendorff, Membership Committee chairman, introduced the new members admitted to the Chapter since last May: E. N. Bowles, G. W. Lindsay, Jr., A. S. Widdowfield and Charles Weinfeld.

Brief reports on the activities of their committees were made by R. E. Hattis, Legislative, and Tom Brown, Meetings and Program.

The speaker of the evening was then introduced by V. L. Sherman. He was Dr. Lloyd Arnold, Professor of Bacteriology and Public Health, University of Illinois College of Medicine, and Bacteriologist of the State Department of Public Health, Chicago. Dr. Arnold's address was on the subject, Influence of Air Conditioning Upon Public Health.

Dr. Arnold stated that a healthy person is one who is adjusted to his environment. His various physiological systems, such as respiratory, digestive, etc., coordinate with each other in a normal manner if he is in perfect equilibrium with the forces in his environment. One of the important environmental factors for man is the physical and chemical properties of the air.

Dr. Arnold explained that man's skin is a part of his heat regulatory system. Man has sweat glands, for the purpose of excreting large volumes of water onto the surface of the skin for cooling or reducing internal temperature.

In the respiratory tract, when the skin is suddenly chilled the nasal capillaries contract. In a healthy person they again dilate within five minutes to warm and moisten the incoming air. The individual suffering, however, from repeated head colds has a sluggish nasal reflex and changes in skin temperature are not compensated for by alterations in nasal circulation. People with hay fever and asthma also have an unstable circulatory reaction.

Artificial air conditioning should create such an environment that the body would not be called upon to use its skin to make these various adjustments and thereby upset the internal organisms. In this way, Dr. Arnold concluded, the health of the public can be benefited by air conditioning. At the same time, unless air conditioning creates gradual changes, he expressed the opinion that it can also be detrimental to the health of the public. The problem is one of adaptation to changes in atmospheric temperature and humidity.

At the conclusion of the paper and discussions President Ries regretfully announced that it was necessary for him to resign because his work has taken him from Chicago to Oberlin, O. According to the constitution, this resignation automatically stepped S. I. Rottmayer, vice-president, up to the office of president and left the office of vice president to be filled by nominations from the floor. John Howatt nominated J. R. Vernon for vice president, a nomination which was seconded by J. P. Fleming. There being no other nominations, J. R. Vernon was named to appear on the ballot to be sent to members and counted at the next meeting, according to the report of Secy. C. E. Price.

Pres. Boyden Speaks at New York Chapter Meeting

October 18, 1937. At a meeting of the New York Chapter held at the Building Trades Club, Col. D. S. Boyden, president of the A.S.H.V.E., was the guest of honor.

President Boyden, following his introduction by W. E. Heibel, president of New York Chapter, presented H. G. d'Issertelle, a charter member of New York Chapter, with a Life Membership Certificate in the Society.

In reviewing the accomplishments of the Society, President Boyden reminded his audience that the A.S.H.V.E. was the only organization of its kind with its own Research Laboratory. Since the inception of the Laboratory in 1918 the Society has spent $600,000 on research. The results have been published in 175 papers presented at annual and summer meetings.

Three new chapters of the A.S.H.V.E. were formed in the past year. These are the Atlanta, Golden Gate, and Omaha-Nebraska. The Society now has the largest membership in its history.

In his technical address, President Boyden discussed the Economic Use of Purchased Steam, and showed that a modern district heating system has an overall thermal efficiency of 63 per cent which compares with efficiencies of 50 per cent for small isolated heating plants and 60 per cent for medium size plants.

The speaker pointed out that district heating began in 1877 when electric utilities began selling exhaust steam for heating at byproduct rates. At that time the lines were of screwed pipe; there were no reliable meters; and charges were made on a flat rate basis. With the introduction of condensing engines and turbines, use of exhaust steam for heating was dealt a severe blow.

A permanent problem of the district heating utility, Mr. Boyden said, is to keep investment and other fixed charges low enough so that district steam can compete with the isolated plant in spite of its low annual load factor. The investment in a district heating plant is from $2 to $4 per pound of steam capacity; of this, the cost of the distribution lines is from 70 cents to $1.35. The cost of installing steam mains is high, totaling about $37.32 per lineal foot for a 12-in. underground main. This cost is made up of $9.08 for pipe, valves and fittings; $4.84 for insulation; $5.06 for excavating and filling; $3.29 for concrete work; $6.25 for paving; $3.50 for engineering, and $5.30 for extras.

Philip Cohen

Northern Ohio Chapter

In the annual report of the Northern Ohio Chapter the following officers and committees are listed as being in charge of activities:

President—Philip Cohen.
Vice-President—H. E. Wetzel.
Secretary—C. A. McKeeman.
Treasurer—A. L. Vanderhoof.
Board of Governors—L. T. Avery, H. M. Nobis, F. A. Rodgers.
Membership Committee—H. E. Wetzel, *chairman*, D. L. Taze, Andrew Simon, Charles Wheeler, H. K. Jennings, H. S. Ackley.
Program Committee—J. P. Jones, *chairman*, L. T. Avery, A. L. Vanderhoof.
Legislation Committee—H. M. Nobis, *chairman*, W. M. Rowe.
Standards Committee—E. B. Cary, *chairman*, G. L. Tuve, H. E. Wetzel, L. T. Avery.
Meetings and Entertainment Committee—R. A. Wilson, *chairman*, Charles Wootan, R. T. Southmayd.
Publications Committee—C. F. Eveleth, *chairman*, E. W. Gray.
Auditing Committee—D. L. Taze, *chairman*, L. O. Weldy.

W. R. Beach reports that at the present time there are 72 members on the rolls. The Chapter is continuing its practice of holding a dinner and business meeting preceding the speaker's address and discussion. It is felt that the past season has been

successful and the Chapter looks forward to the coming year's activities.

The following is a synopsis of meetings held during 1936-37:

October 20, 1936. Subject—Air Conditioning Standards for Cleveland area. Speaker—H. E. Wetzel. Attendance—75.

November 11, 1936. Subject—Economics of Good Construction in Residence Heating and Air Conditioning. Speaker—Prof. G. L. Larson, Madison, Wis., president of the A.S.H.V.E. Attendance—105.

December 14, 1936. Subject—Cooling Requirements for Summer Comfort Air Conditioning. Speaker—F. C. Houghten, director, A.S.H.V.E. Research Laboratory. Attendance—75.

January 11, 1937. Subject—Automatic Control Characteristics. Speaker—A. B. Newton, assistant chief engineer in charge of control design, Minneapolis-Honeywell Regulator Co. Subject—History of Temperature and Humidity Control Design. Speaker—M. F. Rather, Johnson Service Co. Attendance—120.

February 12, 1937. Subject—Reenactment of the 1920 World Series. Speakers—Jack Graney, Elmer Smith and Bill Wamby. Subject—It's Great Stuff If You Can Get Away with It. Players—Philip Cohen, D. L. Taze, R. A. Wilson and E. W. Gray. This meeting was sponsored by the Chapter entertainment Committee. Attendance—90.

March 15, 1937. Subject—Glass as a Building Material. Speaker—E. P. Lockart, Owens-Illinois Glass Co. Attendance—50.

April 21, 1937. Subject—When an Engineer Goes Sightseeing. Speaker—E. H. Gurney, 1st vice-president of the A.S.H.V.E. A general discussion of A.S.H.V.E. national activities followed. Attendance—45.

May 17, 1937. Subject—Solar Heat Gains in Relation to Air Conditioning. Speaker—J. H. Walker, engineering assistant to the president, Detroit Edison Co. Attendance—75.

June 21, 1937. Subject—Self Contained Room Coolers. Speakers—J. G. Harris, Delco-Frigidaire Div., General Motors Sales Corp., A. M. Fenwick, Smith & Oby Co., Mr. Dunning, General Electric Co. Attendance—40.

G. A. Playfair

H. R. Roth

Ontario Chapter

Secy. H. R. Roth has prepared a report of the past year's activities of Ontario Chapter, which numbers 98 members on its rolls. The Chapter officers and committees for 1937-38 are:

President—G. A. Playfair.
Vice-President—H. B. Jenney.
Secretary—H. R. Roth.
Board of Governors—H. D. Henion, J. W. O'Neill, O. L. Maddux, Thomas McDonald.
Attendance Committee—J. H. Fox, *chairman*, Ernest Fox, S. A. Jennings, William Phillip, R. G. Heard, J. J. Lawlor, L. B. Pope, D. O. Price, A. T. Jones.
Papers Committee—C. Tasker, *chairman*, H. H. Angus, E. A. Allcut, L. L. Anthes, A. J. Dickie.
Auditors—A. H. Hills, D. J. MacDonald.
Entertainment Committee—E. R. Gauley, *chairman*, G. E. Cole, A. G. Ritchie, W. C. Kelly.
Greeters Committee—L. C. Blackhall, W. P. Boddington, M. W. Shears, *Membership Committee*—E. T. Whittall, *chairman*, F. E. Ellis, H. S. Moore, F. W. Chambers, E. A. Dowler, W. C. Oke.

The annual report includes a synopsis of meetings held during the season.

October 13, 1936. There were 47 members and guests present. The speaker was Prof. G. L. Larson, Madison, Wis., president of the A.S.H.V.E., who gave a talk on The Economics of Good Residence Construction.

November 2, 1936. There were 50 members and guests present. The speaker was A. J. Connor, Dominion Climatologist, who gave a talk on Weather as Related to Air Conditioning.

December 7, 1936. There were 57 members and guests attending. The speaker was Mr. Mueller who spoke on Automatic Temperature Regulation for Summer and Winter Air Conditioning.

January 11, 1937. There were 98 members and guests present. This was a joint meeting of the *A.S.M.E.* and the A.S.H.V.E. The speaker was C. Tasker, who spoke on Cooling Requirements for Summer Comfort Air Conditioning.

February 1, 1937. There were 72 members and guests present. The speaker was S. A. Armstrong who spoke on Triple Duty Hot Water Heating Systems.

March 1, 1937. There were 53 members and guests present. The speaker was E. H. Gurney, who spoke on Heating, Ventilating and Air Conditioning in South Africa.

April 2, 1937. There were 165 members and guests present. The speakers were F. Meyers, who spoke on The Use of Fibre Glass in Air Filters, and E. P. Lockart, who spoke on Glass Block in Construction.

May 3, 1937. There were 46 members and guests present at the annual meeting.

B. C. Candee

Western New York Chapter

The following officers and Board of Governors were elected at the May 17 meeting to serve for the year 1937-38:

President—B. C. Candee.
1st Vice-President—J. J. Landers.
2nd Vice-President—L. P. Saunders.
Secretary—W. R. Heath.
Treasurer—C. A. Gifford.
Board of Governors—D. J. Mahoney, M. C. Beman, Roswell Farnham, P. S. Hedley, W. E. Voisinet.

President Candee has appointed the following committee chairmen: *Program*—J. J. Landers; *Membership*—L. P. Saunders; *Entertainment*—Joseph Davis.

At the present time there are 66 members on the rolls of the Western New York Chapter and during the 1936-37 season the following meetings were held:

September 7, 1936. Golf meet and dinner at the South Shore Country Club. Attendance—19.

October 12, 1936. Dinner meeting at the Touraine Hotel. Speaker—Prof. G. L. Larson, president of the A.S.H.V.E. Subject—The Economics of Good Construction as Related to Residence Heating. Total attendance—32.

November 9, 1936. Dinner meeting at the Buffalo General

Electric Co. and inspection of air conditioned home. Speakers—T. I. Messenger, Mr. Flick, and John James, technical assistant of the A.S.H.V.E. Subject—Air Conditioning Applied to Fever Therapy. Attendance—36.

December 22, 1936. Social meeting at the University Club. Total attendance—32.

January 11, 1937. Dinner meeting at the University Club. Speaker—W. R. Heath, Buffalo Forge Co. Subject—Discussion of the A.S.H.V.E. research laboratory paper on Cooling Requirements for Summer Comfort Air Conditioning. Total attendance—51.

February 8, 1937. Dinner meeting at the University Club. Speaker—W. E. Voisinet. Subject—Basic Principles of Heat Transfer. Total attendance—35.

March 8, 1937. Dinner meeting at the University Club. Speakers—Joseph Davis and Joseph Scanlon. Subject—Application of Refrigeration and Air Conditioning. Total attendance—39.

April 12, 1937. Dinner meeting at Iroquois Gas Corp. Speaker—R. M. Conner, director of the testing laboratory, *American Gas Association*. Subject—The A.G.A. Seal of Approval—What It Means and How the Standards Are Set.

May 17, 1937. Annual meeting and election of officers at the University Club. Speaker—E. H. Gurney, Toronto, Ont., 1st vice-president of the A.S.H.V.E. Subject—When an Engineer Goes Sight-Seeing.

September 16, 1937. Western New York Chapter members enjoyed a meeting at the South Shore Country Club, when about 19 members and guests played golf, after which dinner was served at the Au Revoir Restaurant to 35 members and guests.

W. E. Voisinet, Paul Mann, M. S. Jackson, S. R. Rente, G. F. Erdle and C. A. Evans were among those rewarded for their skill.

A preliminary announcement was made of the October 11 meeting at the University Club with L. A. Harding as speaker.

Bridge, poker and other games rounded out a very pleasant evening, according to the report of Secy. W. R. Heath.

James Holt

H. C. Moore

Massachusetts Chapter

The annual report of Massachusetts Chapter, prepared by Prof. H. C. Moore, secretary, states that 54 members are on the rolls and the officers and committees in charge of activities for 1937-38 are:

President—James Holt.
Vice-President—C. P. Yaglou.
Secretary—H. C. Moore.
Treasurer—John Turner.
Board of Governors—L. J. McMurrer, J. F. Tuttle.
Meetings and Papers Committee—C. P. Yaglou, *chairman*.
Membership Committee—Philip Drinker, *chairman*.
Social Committee—W. T. Jones, *chairman*.
Representative for A.S.H.V.E. Research Publicity—R. M. Nee.

An outline of meetings held during the past season follows:

October 13, 1936. Supper and meeting at Walker Memorial, M.I.T. W. A. McPherson, heating and ventilating engineer of the Boston School Committee, presented an interesting study on the Performance of Various Methods of Heating and Ventilating Schools under actual operating conditions. Twenty-three members were present.

November 13, 1936. Joint meeting with the Air Conditioning Bureau of Boston. Supper and meeting at Walker Memorial. Prof. G. L. Larson, Madison, Wis., president of the A.S.H.V.E., spoke on the Economics of Good Construction as Related to Residence Heating. Attendance—125 members and guests.

December 15, 1936. Supper and meeting at Walker Memorial. Prof. James Holt spoke on Rational Methods of Determining Heating, Humidification and Cooling Requirements. R. S. Franklin, consulting engineer, spoke on Recent Advances in Methods and Apparatus for Steam, Hot Water, and Warm Air Heating. Attendance approximated 100.

January 19, 1937. Supper and meeting at Walker Memorial. Mr. Carlson, Carrier Corp., spoke on Air Conditioning Homes. L. F. Jackson, The Linde Air Products C.o, spoke on Industrial Pipe Welding. Attendance—70 members and guests.

February 25, 1937. Joint meeting with the Air Conditioning Bureau, National Producers Council Club, *A.S.R.E.*, *A.I.M.M.E.*, and *Boston Oil Burner Association*. Supper and meeting at Boston Chamber of Commerce. Speaker—W. H. Carrier, who after a brief talk on air conditioning mines, showed some delightful travel pictures from South Africa and New Zealand. Over 300 members and guests attended the meeting.

March 19, 1937. The March meeting was observed as Ladies' Night with supper, entertainment and speakers, at Walker Memorial. Enthusiastic support was given to this meeting by about 50 members and guests.

April 20, 1937. Supper and meeting at Walker Memorial. Bruce Hayter, chief engineer, Institute of Thermal Research, American Radiator Co., presented a paper on Performance Characteristics of Oil Burners in Relation to Boiler Characteristics. J. S. Parkinson, acoustical engineer, Johns-Manville, spoke on Sound Control in Air Conditioning.

May 18, 1937. Meeting at the Harvard School of Public Health. B. P. Fonda, air conditioning engineer, Bryant Heater Co., spoke on Adsorption Dehumidification Systems. W. N. Witheridge, instructor, Harvard School of Public Health, spoke on Ozone in Ventilation. Attendance—40.

June 24-26, 1937. Massachusetts Chapter was host to the A.S.H.V.E. for its Semi-Annual Meeting at the New Ocean House, Swampscott.

William F. Gilling

Members of the Massachusetts Chapter and friends of William F. Gilling were saddened to learn of his sudden death at his home in Wellesley Hills on September 23.

Mr. Gilling was born in Chelsea, Mass., on December 13, 1862, and he had been engaged in the heating industry since 1879 when he was associated with the Magee Furnace Co. For four years he was manager for LeBosquet Bros., manufacturers of low pressure heating apparatus, and from 1897 to 1901 he was engineer and salesman for the American Boiler Co., Pierce, Butler & Pierce Manufacturing Co. From 1901 he had been associated with the American Radiator Co. as engineer and assistant manager of the Boston branch.

Mr. Gilling joined the American Society of Heating and Ventilating Engineers in 1919 and was made a Life Member by action of the Council in 1934. He maintained an active interest in the activities of the Massachusetts Chapter.

He was a member of Star of Bethlehem Lodge, A. F. & A. M., Shekinah Royal Arch Chapter and Palestine Commandery, K. T. He was also a member of the Massachusetts Republican Club, the Boston City Club and the Wellesley Country Club.

Mr. Gilling leaves his wife, Mrs. Lillian Reed Gilling, to whom the Officers and Council have expressed their sincere sympathy.

New Laboratory Dedicated

Leaders in science and industry came from various parts of the United States to attend an all day program at the Newark, Ohio, plant of the Owens-Illinois Glass Co. on October 20 when the new industrial and research laboratory was formally opened and dedicated by Dr. A. C. Willard, president of the University of Illinois.

In his address, Dr. Willard pointed out that the new building is to be devoted to scientific research in the new and fascinating field of glass fibre production and utilization and represents an important occasion in the history of glass technology. In the modern world of today he stated, glass serves mankind in a thousand ways. He asked the audience to imagine a glass free world and said that to remove glass from our daily life would stop scientific research and experimental study in chemistry, physics and astronomy; it would also paralyze the profession of medicine, as well as all science and commerce. The new laboratory was conceived and erected to make textiles from glass fibres which he said was a daring adventure in the widening field of glass technology.

In concluding his address Dr. Willard stated that this new laboratory and its staff of scientists, engineers and technicians are embarking on a great adventure, they are about to cross a new frontier in our technological advance through research.

Following a breakfast at Granville Inn., the guests were conducted to the Newark plant of the Owens-Illinois Glass Co. where the laboratory was inspected and following the dedication ceremonies the manufacturing facilities were viewed on a tour of inspection of the factory.

Pres. W. E. Levis greeted the guests and a short history of the glass fibre industry was given by Games Slayter, Research Director. Luncheon was served at the Granville Inn and a special feature was the table service and decorations, all of which were made of glass.

During the inspection trips guides explained the two methods of making glass fibre known as the continuous filament and the staple fibre method. In both processes, glass marbles are fed into electrically heated furnaces and the molten glass enters a V-shape bushing and is drawn downward by gravity in the continuous process, emerging through tiny holes in the bushing as shiny fibres which are combined to make a thread-like strand that can be wound upon spools and then transferred to machines for fabrication. In the staple process, the molten glass is forced down through tiny holes in the bushing by steam at high pressure and the fibres are taken from a revolving drum to be wound on spools for later fabrication. Samples of cloth, tape, yarn and thread were shown.

In the main factory, visitors watched the production of air filters, insulating materials for building and industrial purposes and during the inspection tour of the laboratory building observed the numerous applications of glass block in this new windowless air-conditioned building.

Death of Frank B. Howell

Frank B. Howell, who served the heating industry for more than 40 years while employed in various capacities in the American Radiator Company, died Sunday, October 10, 1937, in the Lenox Hill Hospital in New York. He was 74 years old, having been born in Yonkers, N. Y., in 1863.

Mr. Howell was connected with the Richmond Stove Company before joining the American Radiator Company in 1895 in the New York office. From that time until 1905 he served successively as manager of the Buffalo branch, assistant manager of the Michigan plant in Detroit, and manager of the Bond plant in Buffalo. In February, 1905, he was made superintendent of the eastern branches of the company with headquarters in New York and served in that capacity until 1907, when he was made assistant general manager of sales with offices in Chicago. He was made head of the Institute of Thermal Research in 1913, which was at that time located in Buffalo, and in 1928 was transferred to the executive branch of the company and since that time he served in various capacities until his death.

Mr. Howell was a member of the *American Society of Mechanical Engineers,* serving on the Boiler Code Committee and acting as chairman of the Sub-Committee on Heating Boilers until the time of his death. He became a member of the American Society of Heating and Ventilating Engineers in 1920 and recently was voted Life Membership in the Society. He was a member of the *American Gas Association,* a member of the *Engineers' Club* of New York, and served on the Committee on Heat Transmission of the *National Research Council.*

For the A.S.H.V.E. he was active on many technical committees, served as a member of the Committee on Research, contributed to The Guide, the Code of Minimum Requirements for Heating and Ventilating of Buildings, and the Transactions of the Society.

He is survived by his wife, Mrs. Anne Suhler Howell, one brother, Joseph Howell of Salt Lake City, one sister, Mrs. Lenor Povey of Camden, N. J., a niece, Mrs. Jessie L. Roe, and a nephew, Edwin H. Stickney, both of New York.

The Officers and Council offer their sincerest sympathy to his family and regret the loss of an active, able and valued member of the Society who devoted his life to the development of the heating industry on which he left a deep and lasting mark.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 80 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge the members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by November 15, 1937, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immedia tely after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
AMMERMAN, A. S., Jr., Sales Engr., Aerofin Corp., Chicago, Ill.	J. F. Hale E. P. Heckel	H. D. Jackes J. H. Milliken
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SCHWARTZ, N. E., Air Cond. Engr., York Ice Mach. Corp., Omaha, Nebr.

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SHIRLEY, W. B., Field Engr., Lennox Furnace Co., Charlotte, N. C.

SIEGEL, D. E., Student, Ranken School of Mech. Trades, St. Louis, Mo.

STAHL, W. A., Operating Engr., The Merchandise Mart, Chicago, Ill.

TALLIANOS, P. C., Managing Director, The Egyptian Wireless Co., Alexandria, Egypt.

TIDMARSH, P. M., Vice Pres. & Gen. Mgr., Tidmarsh Engrg. Co., Tucson, Ariz.

TRAWICK, J. G., Dist. Repr., Minneapolis-Honeywell Reg. Co., Birmingham, Ala.

TRAYNOR, H. S., Student Engr., Carrier Corp. (Internatl. Div.), Newark, N. J.

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WINTHER, ANKER, Br. Air Cond. Engr., York Ice Mach. Corp., Cincinnati, Ohio (*Advancement*)

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W. H. Junker Louis Grabensteder	R. E. Kramig, Jr. J. A. Schurman

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

FOOTE, A. G., Dist. Engr., Frigidaire Div., Berkeley, Calif.

JAMES, J. W., Tech. Asst., Am. Soc. Htg. & Vtg. Engrs., New York, N. Y. (*Advancement*)

KEMERY, W. E., JR., Member of Firm, A. E. Doyle & Assoc. Archts., Portland, Ore.

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MARTIN, R. H., Chief Engr., Treadwell Engrg. Co., Los Angeles, Calif.

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MYLER, W. M., JR., Mgr. Space Htg. Engrg. Dept., Surface Combustion Corp., Columbus, Ohio

OAKLEY, L. W., Htg. Engr., Plbg. & Htg. Sales Co., Knoxville, Tenn.

PERSSON, N. B., Design Engr., Delco-Frigidaire Cond. Div., St. Paul, Minn.

SCHROTH, A. H., Sales Engr., Ideal Furnace Co., East Orange, N. J. (*Reinstatement*)

SCOTT, A. F. H., Asst. to Pres., Anthracite Industries, Inc., New York, N. Y.

SILBERSTEIN, B. G., Sales Mgr., Ilg Elec. Vtg. Co., Cincinnati, Ohio

WRIGHTSON, W. T., Eastern Mgr., Garden City Fan Co., New York, N. Y.

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CAPPS, E. L., Sales Engr., Tidewater Elec. Corp., Norfolk, Va.

EISELE, L. G., Secy., Eisele Automatic Htg. Co., Iron Mountain, Mich.

FIGGIS, T. G., Mgr. Air Cond. & Refrg. Dept., Malcolm & Co., Ltd., Shanghai, China (*Advancement*)

FREEMAN, E. M., Sales Engr., Canadian Asbestos Co., Ltd., Montreal, Que., Can.

GAUSEWITZ, W. H., Owner & Mgr., Conditionedaire, Inc., Minneapolis, Minn.

GRIEVES, T. R., Br. Mgr., U. S. Radiator Corp., Buffalo, N. Y. (*Reinstatement*)

HAMLIN, J. B., JR., Htg. Engr., Crane Co., Savannah, Ga.

KILLIAN, T. J., Htg. Contractor, T. J. Killian, Waukegan, Ill.

MILLER, GLEN, Htg. & Vtg. Engr., So. Counties Gas Co., Los Angeles, Calif.

OSBERGER, T. L., Mgr., Standard Sanitary Mfg. Co., Grand Rapids, Mich.

ROY, A. C., Dist. Sales Mgr., Hoffman Specialty Co., New York, N. Y.

SAMUELS, SIDNEY, Pres., Sidney Samuels, Inc., New York, N.Y. (*Reinstatement*)

SCHREIBER, H. W., Sales, Johnson Service Co., Milwaukee, Wis.

SHARP, J. R., Htg. & Air Cond. Repr., Public Service Elec. & Gas Co., Hackensack, N. J.

TANGER, O. C. F., Director, N. U. Technische Handelsmaat-Schappij, Arnhem, Netherlands

YERKES, W. L., Engr., Carrier Corp., Philadelphia, Pa.

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NOTTBERG, HENRY, JR., Engr., U. S. Engrg. Co., Kansas City, Mo.

SCHECHTER, J. E., Sales Engr., Barker Bros., Los Angeles, Calif.

SCHULEIN, E. H., Engr., Birchogkrogboe, Copenhagen, Denmark.

ULLRICH, A. B., JR., Sales Engr., Texas Power & Light Co., Dallas, Texas

[Continued from page 692]

This gives the value of $\frac{P_2}{P_1}$ for which the value of W, the flow, is a maximum. The dotted curve of Fig. 3 was plotted from [2].

Referring to [1] above, when the pipe is long, the value of

$$\left(\frac{2}{N} \log_e \frac{P_1}{P_2} \right)$$

becomes negligibly small and [1] reduces to

$$N \left(\frac{P_2}{P_1}\right)^2 = 1 - \left(\frac{P_2}{P_1}\right)^2$$

$$\frac{P_2}{P_1} = \frac{1}{\sqrt{N+1}}$$

But when N is greater than 100, this formula may be written as follows with only a negligible error:

$$\frac{P_c}{P_1} = \frac{1}{\sqrt{N}} \quad \text{.....[3]}$$

The symbol P_c for the critical pressure has been written for P_2.

The value of the maximum discharge W_M is found by substituting [1] of this appendix into [1] of Appendix 4, which yields:

$$W_M = \frac{P_c}{P_1} A \sqrt{g p_1 d_1} \quad \text{.....[4]}$$

This is Formula 15 of the text. It is interesting to note that if both sides of [4] are multiplied by $\left(\frac{V_1}{A}\right)$ and making use of the isothermal relationship, $P_1 V_1 = P_c V_c$, and $WV = UA$, that [3] reduces to

$$U = \sqrt{g P_c V_c}$$

In other words, the maximum velocity of the gas is equal to the velocity with which a pressure wave could be propagated isothermally through the fluid when it is at the critical pressure.

Refutes Idea That Air Conditioning Will Cause Water Shortage

Probable Water Consumption for Air Conditioning Less Than One Per Cent of Total, Says Engineer

POINTING out that a typographical error in a recent government report concerning the effect of air conditioning equipment on urban water supply had led to widespread misunderstanding on the part of the public and many city officials, R. S. Thurston[1] declares that the probable water consumption for air conditioning is less than one per cent of the nation's total water consumption.

The report was prepared by the marketing research division of the Bureau of Foreign and Domestic Commerce, and was intended to furnish purely statistical data on water supply and disposal facilities of urban areas in the United States having a population of 100,000 or more. On the basis of the findings, air conditioning manufacturers presumably could avoid concentrating sales efforts in sections where water supply was barely adequate to meet current demand.

The mistake that precipitated the misunderstanding occurred when the report quoted General Electric engineers as saying that one horsepower of air conditioning, using water at 75 F temperature, would consume approximately 100 gallons of water per minute. The word should have been "hour," according to Mr. Thurston.[2]

N. H. Engle, acting director of the Bureau of Foreign and Domestic Commerce, has admitted the error, adding further that on this basis the present water-using air conditioning equipment of the country, running on a 12-month-24-hour-day basis, has a potential gross water demand of more than 151 billion gallons annually, instead of the 700 billion gallons previously reported.

"As a matter of fact," Mr. Thurston points out, "no air conditioning system operates on a 12-month-24-hour-day basis. Typical operating periods for systems using water for condensing cooling run from 500 to 1200 hours per year, the average being more nearly 750 hours. If 40 per cent of all installations use local water supplies, and if an average rate of 100 gallons per horsepower per hour is accepted, the total of all installations in the United States at the end of 1936 would have been consuming approximately 13 billions of gallons instead of 151 billions, or the 700 billions previously reported. It would seem that the probable water consumption for air conditioning is less than one per cent of the total consumption."

Mr. Thurston stated that in isolated cases there is a definite restriction on the use of water for air conditioning, either because of limited supply or limited sewerage facilities, but that these conditions have long been recognized. Wherever such a condition exists, it has been general practice to include in the system a water conserving device, such as a cooling tower or evaporative condenser. Even in communities where there are no such limitations, he adds, such devices are often included as a matter of economics, because for installations of a certain size it is often less expensive to amortize the additional investment than to pay water bills over a period of years.

[1] Engineer, General Electric Co.

[2] The figure quoted in the report for the amount of water consumption for air conditioning was questioned by HEATING, PIPING AND AIR CONDITIONING as soon as it was issued. However, as our review (pp. 480-483, August, 1937) was confined to a discussion of available water facilities of various cities and reproduction of water and air temperatures from the report, and not to the water requirements of air conditioning plants, mention was neglected of the obvious discrepancy.—EDITOR.

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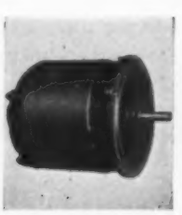

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Air Conditioning Society of San Francisco Adopts Standards for Air Conditioning

The Air Conditioning Society of San Francisco has recently adopted the "California Standards of Air Conditioning for Human Comfort," the compilation of which was the work of a committee over a period of eight months, during which nearly 30 meetings were held. C. C. Hardy was chairman of the standardization committee and the other members were: *Summer*—H. L. Lincoln, chairman, Frank Jordan, Frank Hook, and W. W. Sandholt. *Winter*—Dr. B. M. Woods, chairman, H. D. Eddy, J. A. Hill, and W. W. Cockins. Copies of the standards are available from members of the Air Conditioning Society.

These suggested standards are to be construed as defining recommended minimum practice that may be considered as air conditioning, says the committee. They should not be used to hinder progress nor to prevent the use of other specifications where such are economically justified. Where installations are made below these minimum requirements, they should be called by some other name than "air conditioning."

The standards are based mainly on the *Guide* of the American Society of Heating and Ventilating Engineers, 1937 edition; the *Refrigerating Data Book* of the American Society of Refrigerating Engineers, 1937-38 edition; the *Interim Code of Application Engineering Standards* of the Air Conditioning Manufacturers' Association; the *Code for Warm Air Heating;* and the *Chicago Standards for Comfort Air Conditioning,* all adapted to meet the particular conditions existing in California in the hope that specifications prepared for air conditioning installations may be better understood; that the equipment offered to meet these specifications be more uniform; and that the performance of that equipment is consistent with the ideas of those issuing the specifications.

Following a section on definitions of terms used in air conditioning, which is not quoted here, the standards are as follows:

SECTION 1. SCOPE—These standards are intended to summarize existing good practice in the design of air conditioning apparatus for human comfort in California in winter as well as in summer.

SECTION 2. DESIGN COEFFICIENTS FOR HEAT TRANSFER THROUGH VARIOUS BUILDING CONSTRUCTION AND FOR HEAT GAINS FROM PEOPLE OR APPLIANCES—Shall conform to the standards recommended by the current issue of the *Guide.*

SECTION 3. MINIMUM STANDARDS FOR COOLING APPARATUS—The necessary cooling may be provided by refrigerating machinery, evaporative cooling, cold well water, water cooled by ice, or a combination of these, to suit the preference of the owner, and shall not be called air conditioning unless the performance of the system installed complies with these standards.

Refrigeration apparatus shall conform to the current issue of the *Refrigerating Data Book.* For the purpose of these standards the rating of refrigeration apparatus shall be based on an evaporative temperature of 40 F, and a condensing temperature of 86 F.

When refrigeration is supplied by melting ice, the rating will be based on the melting of 83 lb of ice an hour to deliver 1 ton of refrigeration.

Where cold water is the refrigerant, the rated capacity of such systems shall be determined on the basis that 1 ton of refrigeration is delivered when 5 gpm of water are circulated through the system and the temperature is raised 5 F. However, unless provision is made to control both the temperature and the

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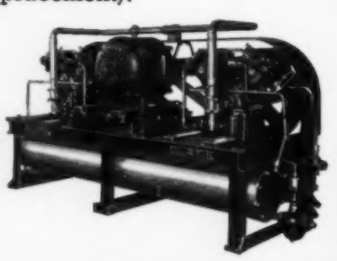
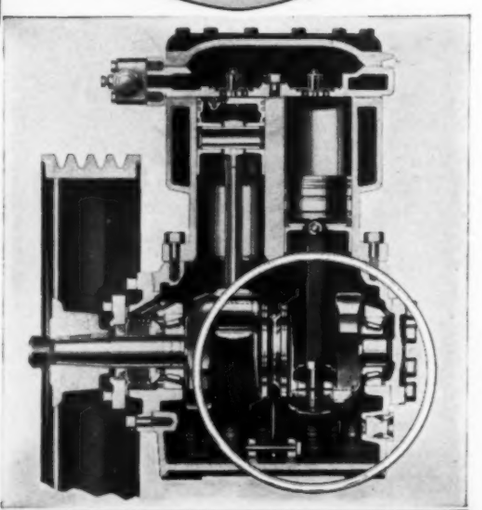


Tapered Roller TIMKEN BEARING EQUIPPED

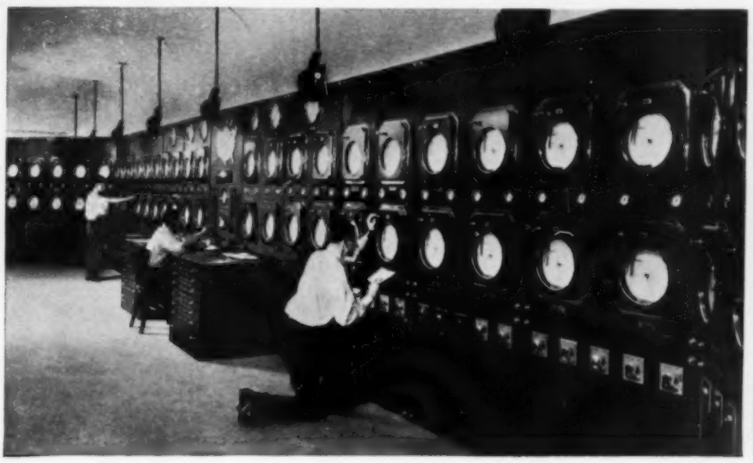


CURTIS
"Builders of Condensing Units Since 1922"

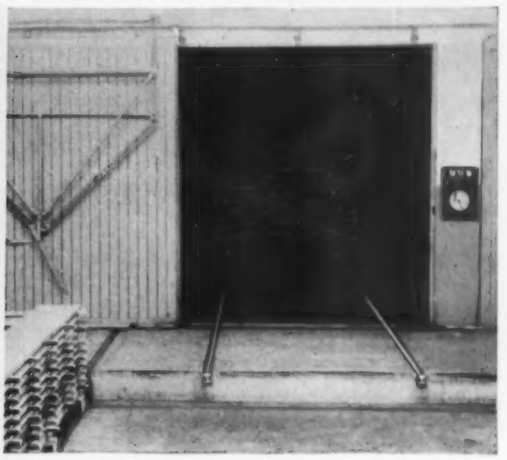
CURTIS REFRIGERATING MACHINE CO.
Division of Curtis Manufacturing Co.
1950 KIENLEN AVENUE ST. LOUIS, MO.

Represented in Canada by
Canadian Curtis Refrigeration Co., Ltd.
20 George St., Hamilton, Ont., Can.

RADIO—Sixty-four Taylor Recording Controllers provide individual temperature control for National Broadcasting Company's studios and offices, maintaining desired air conditions within ½° F. These instruments control and record the temperature of 23,000,000 cubic feet of air per hour, providing a complete change of air every eight minutes.



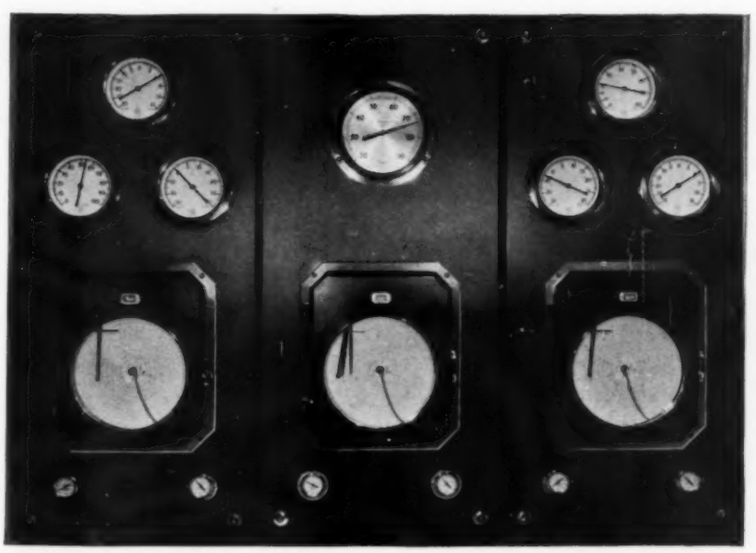
LUMBER-DRYING KILN—Fulscope Wet-and-Dry-Bulb Recording-Controlling Hygrometer controls heat and moisture, prevents overheating and steaming. Chart record gives temperature, humidity and drying time. Exact control cuts steam cost.



SIMPLE COOLING OR COMPLETE AIR CONDITIONING

Wherever you manufacture weather for Products or People, rely on Taylor Control of Temperature and Humidity for more efficient operation

DEPARTMENT STORE—Fulscope Controllers regulate brine and cold water supply. Reset Controller on every floor holds indoor temperature at predetermined point in relation to outdoor atmosphere for maximum summer comfort.



NEW YORK SKYSCRAPER—Central instrument on panel is Taylor Fulscope Dubl-Duty Recording Controller. Automatically controls and Records both wet- and dry-bulb temperatures. Resets the Reset Fulscope Controllers (on either side) in accordance with variations in outside atmosphere. Control points of Reset Controllers are automatically adjusted to maintain comfortable indoor weather in proper relation to outdoor temperature and humidity. *Savings in steam with this control system paid for the Taylor Instruments in one winter.*

IN INDUSTRIAL PLANTS or commercial buildings—wherever air conditioning is needed today—Taylor Control is an important factor in creating ideal indoor weather conditions. Backed by long experience and thorough knowledge of instrument application, Taylor Engineers are well equipped to design complete systems of coordinated temperature and humidity control for every type of air conditioning installation.

For complete information on Taylor Control in Air Conditioning and for the special catalog of Taylor Instruments for air conditioning, heating and ventilating systems, ask a Taylor Representative. Or write direct to Taylor Instrument Companies, Rochester, N. Y. Plant also in Toronto, Canada. Manufacturers in Great Britain—Short & Mason, Ltd., London, England.

Taylor

Indicating • Recording • Controlling

TEMPERATURE, PRESSURE, FLOW *and* LEVEL INSTRUMENTS

humidity to within the comfort zone, the system shall not be designated as air conditioning but may be called comfort cooling.

When, in a cooling system, 5 tons of refrigeration is added to 5 tons of water cooling, the combined system may be rated as a 10 ton air conditioning apparatus.

SECTION 4. MINIMUM DESIGN TEMPERATURES AND HUMIDITIES FOR COMFORT HEATING—Outside design temperature shall be no higher than five degrees above the minimum reported temperature set forth by the various government weather stations in the respective towns under consideration. Inside temperature shall be seventy degrees Fahrenheit. The humidifying apparatus shall be designed to furnish a maximum relative humidity as given below corresponding to the following outside temperatures:

Outdoor Air Temp. F	Maximum allowable relative humidity in per cent in room at which frost or condensation appears on window panes (based on 69 F room temperature). Double Sash 1½ in. Air Space	Double Glazed ½ in. Air Space	Single Glazed
10	45	32	18
20	53	40	25
30	60	48	35
40	68	58	45

SECTION 5. MINIMUM DESIGN TEMPERATURES AND HUMIDITIES FOR COOLING—This involves the controlling of both temperature and humidity under contrasting conditions of "normal" climate as existing in Chicago or Los Angeles and a dry climate as existing in Fresno or Phoenix. Apparatus that will serve in one location and meet the standard requirements for air conditioning may not satisfy these requirements in the other.

The *Guide* gives the following table indicating room conditions that a majority of people find comfortable:

Normal Climate
(Constant Dew Point 57)
Indoor Air Conditions

Outdoor* Temp.	Effec. Temp.	Dry Bulb	Wet Bulb	Relative Humidity
95	73	80	65	44%
		82	57	33%
90	72	78	64½	47%
85	71	76½	64	50%
80	70	75	63½	52%

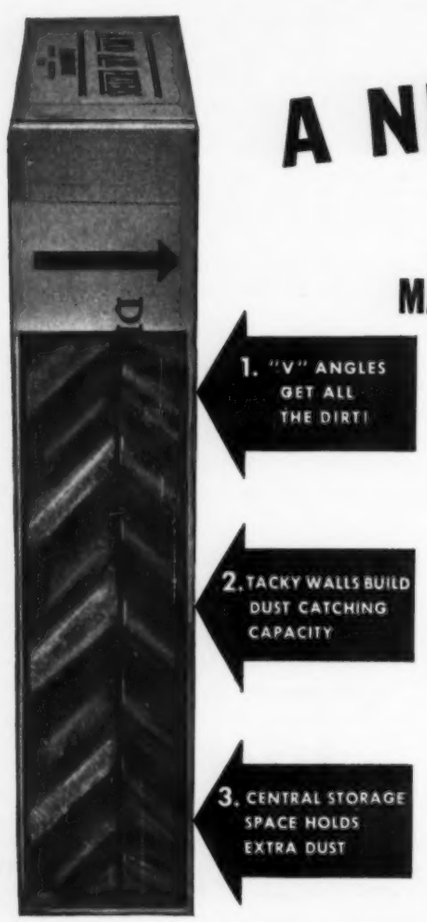
The *Guide* also points out that this may be appreciably modified, provided the effective temperature is not changed. This is another way of saying that as the room temperature is increased, the relative humidity must be reduced. As the table does not provide for outside temperatures in excess of 95 F, it falls short of the summer conditions prevailing in the California Valleys. Experience shows that for the hot dry climate existing there it is necessary to take advantage of the suggestion of modifying the room conditions, provided appropriate effective temperatures are maintained. For such hot dry climates observations indicate the following conditions to satisfy a majority of occupants in air conditioned rooms. For each effective temperature two indoor dry bulb temperatures and appropriate relative humidities are given.

Indoor Air Conditions

Outdoor* Temp.	Effec. Temp.	Dry Bulb	Wet Bulb	Relative Humidity
105	75	83	66	40%
		86	63	25%
100	74	81½	65½	42%
		84	62½	27%
95	73	80	65	44%
		82	62	30%

SECTION 6. INFILTRATION AND LEAKAGE—Design capacity to care for infiltration of air from outside shall be provided in all

*Outside design temperature selected should be that recorded at least ten times during a hot summer.



A NEW KIND OF FILTER

for Air Conditioning

MAKE IT A PLUS FEATURE ON YOUR EQUIPMENT

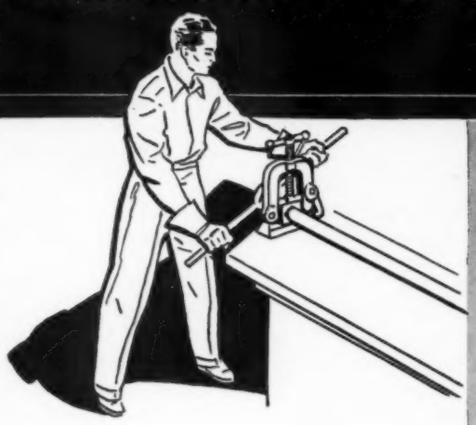
THESE are the points to look for in the filters you use on your equipment. 1. "V" angle construction which makes the air change direction quickly and scrubs it clean. 2. Side walls with a sticky coating that catches dirt and increases efficiency with use. 3. A space between the two wafers which acts as an added storage space for the dust that is collected.

There is one of these efficient Arco Air Filters for every kind of air conditioning equipment. They are light, odorless, inexpensive, and won't drip oil even at 180 degrees F. No dry dust can pass through into the air stream. They assure greater satisfaction for your customers, more impressive selling points for you. Write today for complete details.

INDUSTRIAL DIVISION
AMERICAN RADIATOR COMPANY
DIVISION OF AMERICAN RADIATOR & STANDARD SANITARY CORPORATION
40 West 40th Street, New York, N. Y.

ARCO Air FILTERS

HE PRIDES HIMSELF ON WORK AND SERVICE



-but, Plumber, what of the Pipe?

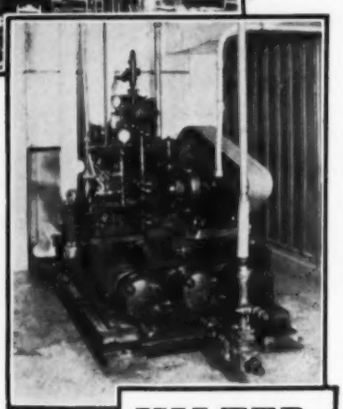
Jobbers all over the country stock Fretz-Moon Steel Pipe in steel or rust-resisting copper-bearing steel—black or galvanized. If your jobber does not carry it—write us.

Good first-class work and unfailing service earn the respect of customers—build business—insure profits in the future. • But, Mr. Plumber, have you ever considered going a step further toward establishing sound business by giving better piping to your customers at no extra cost—and by using pipe that helps to strengthen the profit side of your ledger? • Many plumbers are doing just that with Fretz-Moon Pipe—the modern steel pipe made by the exclusive "continuous process" that eliminates all guess work from pipe making. Fretz-Moon Pipe is exceptionally uniform—sound in weld; clean and free from scale inside and outside; highly ductile, without hard or "burnt" spots; easy to bend without flattening; easy to cut and thread . . . and it comes to you with accurate, sharp threads on pipe and in couplings. The galvanized surface will not scale at bends. • Why not investigate this better steel pipe? . . . Ask your jobber . . . or write us for the full story.

FRETZ-MOON TUBE CO., INC.
BUTLER • PENNA.

TRY FRETZ-MOON PIPE AND KNOW THE DIFFERENCE

ANOTHER..



HOTEL PLANKINTON
Milwaukee, Wis.

PLANKINTON
COFFEE SHOP

VILTER "FREON"
COMPRESSOR UNIT

famous
HOSTELRY
with AIR
CONDITIONING
by
VILTER..

VILTER
Equipment
at
WORK

Tribute to Vilter's seventy-year reputation for efficient Refrigeration and Air Conditioning, the Plankinton House installation adds another famous name to a long list of satisfactory Air Conditioning jobs, by Vilter.

Long experience in the "Modern" Air Conditioning Industry, — experience that cannot help but indicate leadership in an industry demanding the finest of engineering, the best of mechanical efficiency, economy, and dependability. Every Vilter installation testifies to that leadership, confirmed not only by the owner but also by the men responsible for the maintenance and operation of each installation.

Profitable Air Conditioning and Refrigeration depends upon the ideal combination of Engineering Experience and Mechanical Dependability. Refrigeration Engineers everywhere can vouch for this Ideal expressed in all Vilter Equipment. Write for details on recent Vilter Installations.

VILTER
Manufacturing Company
2148 South First Street
Milwaukee - Wisconsin

systems in accordance with the latest issue of the *Guide*.

SECTION 7. DESIGN LOAD CALCULATIONS—Quotations shall include a statement of the load calculations upon which any proposal is based.

(a) For winter air conditioning shall include allowances for heat loss through:
  (1) Physical barriers such as walls, doors, windows, ceilings, floors, etc.
  (2) Infiltration.
  (3) Outside air for ventilation by mechanical means.

(b) For summer air conditioning shall include appropriate allowances for heat gain into the occupied zone through:
  (1) Physical barriers such as walls, doors, windows, ceilings, floors, etc.
  (2) Infiltration.
  (3) Outside air for ventilation by mechanical means.
  (4) Sun heat.
  (5) Heat and moisture from occupants.
  (6) Heat and moisture from appliances, illumination, combustion, etc.

The basis of all of these allowances shall conform with the coefficients in the current issue of the *Guide*, except where these standards give other specific requirements.

SECTION 8. DESIGN ALLOWANCE FOR SHADING FROM SUNSHINE—Shall be made only when the plans and specifications show specifically such allowances, and when they give assurance that the owner is cognizant of the reduction in capacity on this account.

SECTION 9. DESIGN AIR QUANTITY—If the heat is to be conveyed into the room or out of the room by the air, either when heating or when cooling, the quantity and temperature and moisture condition of the air must be such as assuredly will accomplish the work.

In addition, air conditioning shall provide for an introduction of at least 10 cfm of outside air per occupant. For restaurants, beauty parlors, rooms used for heavy smoking, and other rooms with special sources of contamination, this shall be increased to a minimum of 15 cfm per occupant. It is strongly recommended that the air delivery shall be not less than 30 cfm per person in the conditioned room. However, the velocity of the air 36 in. above the floor shall not exceed 50 feet per minute.

SECTION 10. DESIGN DUCT CAPACITY—Provision may be made in the duct design for recirculation of the full capacity of the fan for economical heating or cooling prior to occupancy. In some localities it is desirable to have the inlets, outlets and ducts arranged to draw the full capacity of the fan from outside of the building in order to take advantage of naturally satisfactory outside conditions.

SECTION 11. DESIGN AIR DISTRIBUTION—Shall be such that:

(a) There shall be no mechanically produced air velocity within the occupied zone exceeding 50 feet per minute. However, this will not prevent the use of deflectors, diffusing grilles, nozzles, and the like with comparatively high velocity air currents above the occupied zone.

(b) The difference between the temperature of air currents in the occupied zone and the average temperature of the occupied zone shall not be greater than as shown below for the various air current velocities.

Air Current Velocity	Temperature Difference Temperatures must not be taken nearer than 5 ft from the floor or inlet register
Feet Per Minute	Average T Minus Current T
40 and over	2
Less than 40	3

(c) The temperature shall not vary more than 2 F at the same level within the occupied zone.

(d) Each branch of a duct system shall be provided with means for adjusting the air volume delivered.

SECTION 12. REFRIGERATING APPARATUS AND REFRIGERANTS—All refrigerating and cooling equipment, piping, water supply and drain connections, electric wiring, etc., shall be installed in a way

The Welded Steel Burnham ranges in capacities from 1800 to 42500 sq. ft.

This is the Cast Iron Big Twin Burnham. Made in twin sections so it can be passed through any average door. "No tearing out" necessary. Used extensively for replacements.

Hank **Says:**

One Is As Good As The Other, And Better

(Being one of his Lies that's the truth)

If there's one thing more than another that gets my goat, it's what my grandad used to say wuz, one thing more than another.

Now take these high and mighty fellers that only has steel boilers to sell, cause they don't make no others. You'd think to hear 'em talk, that steel boilers would best do, anything from heating the baby's milk, to warming all outdoors. And do 'em all, such as no cast iron boiler could even start at doing so well.

Then, there's the feller who only makes cast iron, who makes just as much of a yapping about as how, his heats the baby's milk too, and on into the night.

To my notion—and it's once more the Boss agrees with me—sorter seems there's a place for pretty much everything. The job is to get the right one in the right place. There's jobs for cast iron boilers and jobs for steel.

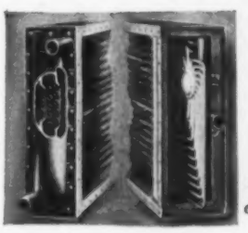
Making both as we do, we ain't no-wise prejudiced. So more 'an likely, when we recommend one or the other, it's because it's the best one to recommend.

Hank Hindler

Burnham Boiler Corporation
Manufacturers of Heating Equipment Since 1873
Irvington, New York - Zanesville, Ohio

Burnham Boiler

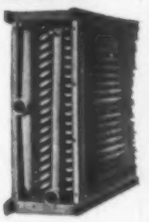
AEROFIN
Heat Exchange Surface

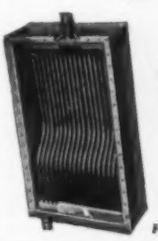


Cleanable Tube Unit with Removable Header

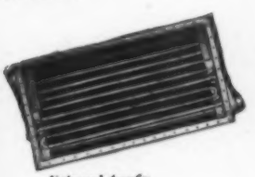
Direct Expansion Unit with Centrifugal Header

Aerofin Continuous Tube Water Coil

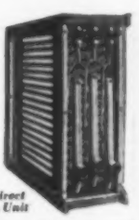




Flexitube Aerofin



Universal Aerofin



Aerofin Direct Expansion Unit

OFFERS EVERYTHING For Heating & Cooling

There is 50,000,000 feet of experience in back of Aerofin heating and cooling surface.

For more than 15 years Aerofin engineers have been designing and building a heat exchange surface which is the standard of comparison by which all equipment of this nature is judged.

Is it any wonder, therefore, that architects, engineers and contractors almost invariably select Aerofin surface to solve their problems?

This vast experience makes Aerofin the dependable choice of the leaders in the Air Conditioning, Heating and Ventilating fields.

Investigate the merits of Aerofin standardized, light-weight heat exchange surface on your next problem. Send for descriptive literature today.

AEROFIN is sold only by Manufacturers of Nationally Advertised Fan System Apparatus. List upon Request

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ANEMOSTAT

Gives Draftless Air Diffusion

Office of the
American Airlines, Inc.
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New York

ANEMOSTAT HIGH VELOCITY AIR DIFFUSER

The Anemostat is an accepted scientific achievement. It has solved major problems of the Air Conditioning Industry by reducing the speed of air flow to such an extent that it is no longer perceptible as a draft. The Anemostat mixes room air with conditioned air within the device, thus the predetermined room temperature is established considerably above the breathing level. The Anemostat permits greater temperature differentials, smaller ducts, smaller plants, lower installation and operating costs. The Anemostat can be applied to existing systems as well as to new installations.

Travelers and the employees of the American Airlines, Inc. can discuss travel plans in perfect comfort in the air conditioned passenger office of this great organization without experiencing the harmful and unpleasant sensation of draft.

Installation Data:

Length of Room	—22′
Width of Room	—20′
Height of Ceiling	—21′
Velocity in Anemostat neck	—1150 fpm
Temperature Differential	—15°
Volume of air distributed through Anemostat	—1200 cfm
Neck diameter of Anemostat	—14″
Diameter of largest cone	—35″

The center of the ceiling is vaulted. The Anemostat is set in the center of the vaulted section. Light members are concealed behind a vertical ring which finishes the ceiling design. These light members throw the light into the vaulted section of the ceiling and onto the Anemostat, resulting in a splendid and unusual indirect lighting effect.

"No Air Conditioning System is better than its Air Distribution"

ANEMOSTAT CORP. of AMERICA

10 East 39th Street • New York, N. Y.

to meet the requirements of the various state and city laws and ordinances. Particularly, the designer and contractor should ascertain conditions under which the installation is to be made. Pending confirmation of particular rulings, the following should be assumed:

(a) Condenser cooling water obtained from wells—68 F; from cooling towers—75 F.

(b) Should an inflammable, irritant or toxic refrigerant be used, there should be a receiver of sufficient capacity to contain the entire operating charge, provided with valve and facilities for storing all of the refrigerant in the receiver.

Should any portion of the apparatus be used for both heating and cooling during the same season, provision shall be made to protect the evaporator from temperatures that will develop a greater pressure than it is designed to carry.

(c) Evaporators, condensers and expansion valves shall be installed with sufficient stop valves and proper fittings to permit servicing or quick removal of operating parts without exposing occupants to refrigerant gases.

(d) All apparatus shall be made of sound material suitable for the work and amply strong to withstand the conditions to which they will be exposed. Installations shall be made in a workmanlike manner and all equipment and connection piping firmly secured in place.

SECTION 13. HEAT TRANSFER APPARATUS—(a) All convectors where condensation might occur when cooling shall have drain pans with tubing running to a drip with air break above a trapped sewer connection or its equivalent.

(b) No fixed spray humidifier or spray dehumidifier shall be installed above the basement of a building unless there shall have been installed under it a water-tight pan graded to a drain so that in case of leakage or overflow there shall be no danger of water damage to the rooms under the apparatus.

(c) Eliminator plates shall be provided for spray humidifiers or for spray dehumidifiers and shall be made of some durable material and so designed as to be easily replaceable.

SECTION 14. NOISE CONTROL—Noise resulting from the operation of an air conditioning system should not exceed the loudness level of the noise in the room when the normal activities in the occupied space are in progress and no part of the air conditioning system is operating.

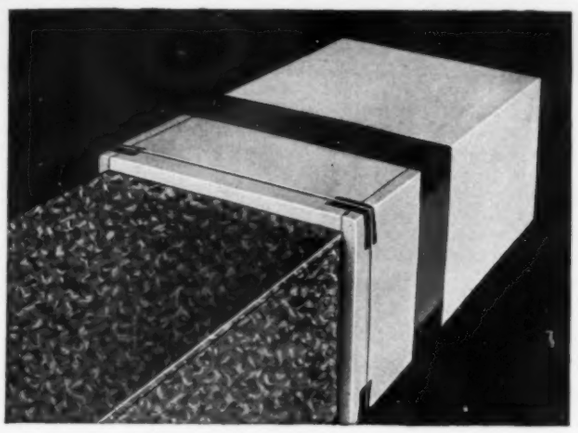
SECTION 15. AIR FILTERS—Devices installed in a system for the removal of suspended matter or particles causing odors shall have a capacity of dust arrestment of at least 75 per cent when tested in accordance with the standards of rating contained in the *Guide*.

Air filters shall be easily accessible for inspection and removing without danger of spilling dust into any duct intake when the substitution is made.

SECTION 16. INSULATION—In air conditioning work in which refrigeration is employed, all chilled surfaces exposed to temperatures and humidities which deposit dew shall be insulated at least to such an extent that no condensation shall gather outside of the insulation.

SECTION 17. GUARANTEES—Specifications shall state the conditions under which air conditioning systems are to operate to produce the required results. When guarantees of performance are required, the specifications shall state the conditions to be maintained, which shall be of such a nature that they frequently recur and may be accurately measured. The tests of the apparatus shall be limited to the capacities and conditions that have been called for. In addition to performance guarantees, manufacturers' guarantees on the mechanical equipment shall be passed on to the customer.

SECTION 18. GENERAL RECOMMENDATIONS—If a proposed installation differs from the provisions of these standards, the particulars in which the design departs shall be stated in the specifications and proposal. No provision of these standards shall be construed to conflict with the requirements of any local, state or other governmental building or regulatory acts.



Here is the PERFECT Insulation *for* Air Conditioning Ducts...

Careycel

CAREYCEL not only keeps in the warm air in winter, but it also prevents the cold air from getting out in summer. It combines the low heat transmission of organic structures, such as cork or hair, with the fireproof qualities of Asbestos. Made in convenient size sheets, it is easy to fit and apply. Samples and complete details mailed upon request—address Dept. 25.

Illustration shows smallness of air spaces in Careycel as compared with ordinary air-cell. This is the principal reason for the higher efficiency of Careycel, and is made possible by the exclusive Carey process of "cellizing" the asbestos sheets.

THE PHILIP CAREY COMPANY

Dependable Products Since 1873

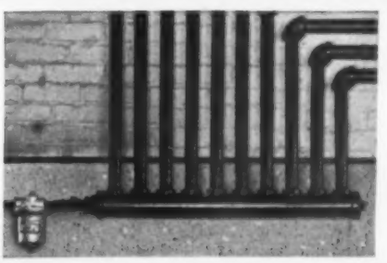
Lockland, Cincinnati, Ohio

BRANCHES IN PRINCIPAL CITIES

Careycel ASBESTOS INSULATION

Anderson Super-Silvertops Give You • • •

1 25% MORE HEAT FROM THIS HEATER



2 HEAT 50 MINUTES SOONER

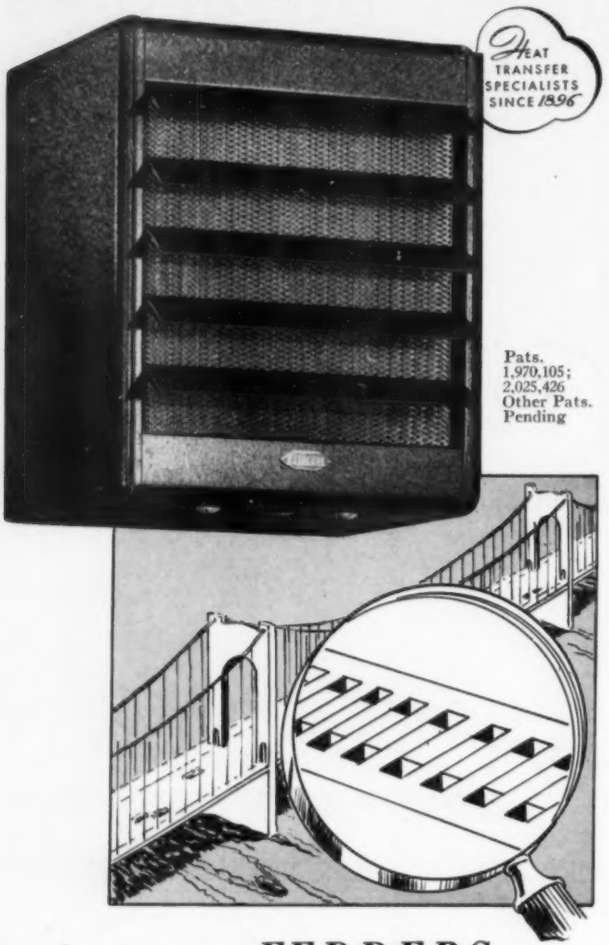
3 SIMPLIFIED PIPING and LOWER INSTALLATION COST

● Anderson Super-Silvertop, the complete steam trap, offers ... more heat ... quicker heat ... simplified piping. Other advantages: greater capacity, works on vacuum *and* pressure, only trap with guided bucket, gives fast air elimination at any pressure. Write for further details about the only complete steam trap.

THE V. D. ANDERSON CO.

1949 WEST 96TH STREET • CLEVELAND, OHIO

BIG BRIDGES
are Protected Against
EXPANSION



Pats. 1,970,105; 2,025,426 Other Pats. Pending

and so are FEDDERS UNIT HEATERS

Expansion stresses are far more severe in Unit Heaters than in bridges because of wider and more sudden temperature changes. Fedders Unit Heaters have exclusive full-floating telescoping mountings which permit free movement of the heating element vertically in cabinet and also protect it from torsional stresses. Tubes having 3 to 1 streamline ratio and individual convoluted fins allow each tube to "give" laterally, thus relieving differential expansion stresses within the element. This also allows the use of curved, non-diaphragmatic headers, assuring a stable heating element. Fedders convoluted fins are saddled over sides of tubes, to eliminate heat expansion stresses between fin and tube, thus maintaining a permanent thermal bond. Accordion design of fins eliminates stresses between bonding points.

Quieter operation and handsome, sturdy mono-piece cabinets make Fedders Unit Heaters ideal for commercial as well as industrial applications. Write for Bulletin 572.

FEDDERS MANUFACTURING CO., Buffalo, N. Y.

Air Conditioning Units—Blast Heating and Cooling Surface

Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 154. Add the new products and companies listed here to your Directory Section which you received in your January, 1937, HEATING, PIPING AND AIR CONDITIONING and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed.

Prevents Sweating of Expansion Valves

No. 1332—When thermostatic expansion valves are so installed that they are exposed to room temperatures they are prone to frost up or sweat and the resulting dripping is frequently objectionable. To prevent this condition an "Anti-Sweater" for its thermostatic expansion valves has been developed by one manufacturer.

The anti-sweater is molded of specially treated composition to tightly fit the valve body and prevent the possibility of air pockets. It is split on one side only thus making it quickly and easily applied—even to valves already installed. Grooves are molded in top and bottom providing a simple aid when attaching to the valve. It can be held in place by tying with soft wire or waxed cord.—Detroit Lubricator Co., 5900 Trumbull Ave., Detroit, Mich.

Magnetic Gas Valves Announced

No. 1333 — New magnetic gas valve of the silent solenoid type has been designed particularly for applications where quietness, ease of installation and freedom of service are required, according to the maker. The new types will be offered in ⅜, ½, and ¾ in. sizes.

These two wire valves are also included in the new gas regulator packages simultaneously introduced.

The valves are furnished only in straight through pattern with screwed ends. All standard models are offered at 110 volts 50 and 60 cycles.—Minneapolis-Honeywell Regulator Co., 2701 Fourth Ave., S., Minneapolis, Minn.

Improves Torch Cutting Machine

No. 1334—Improved torch cutting machine duplicates in design any pattern required for pipe welding jobs and does not

A NEW INSTRUMENT OF EXCEPTIONAL MERIT

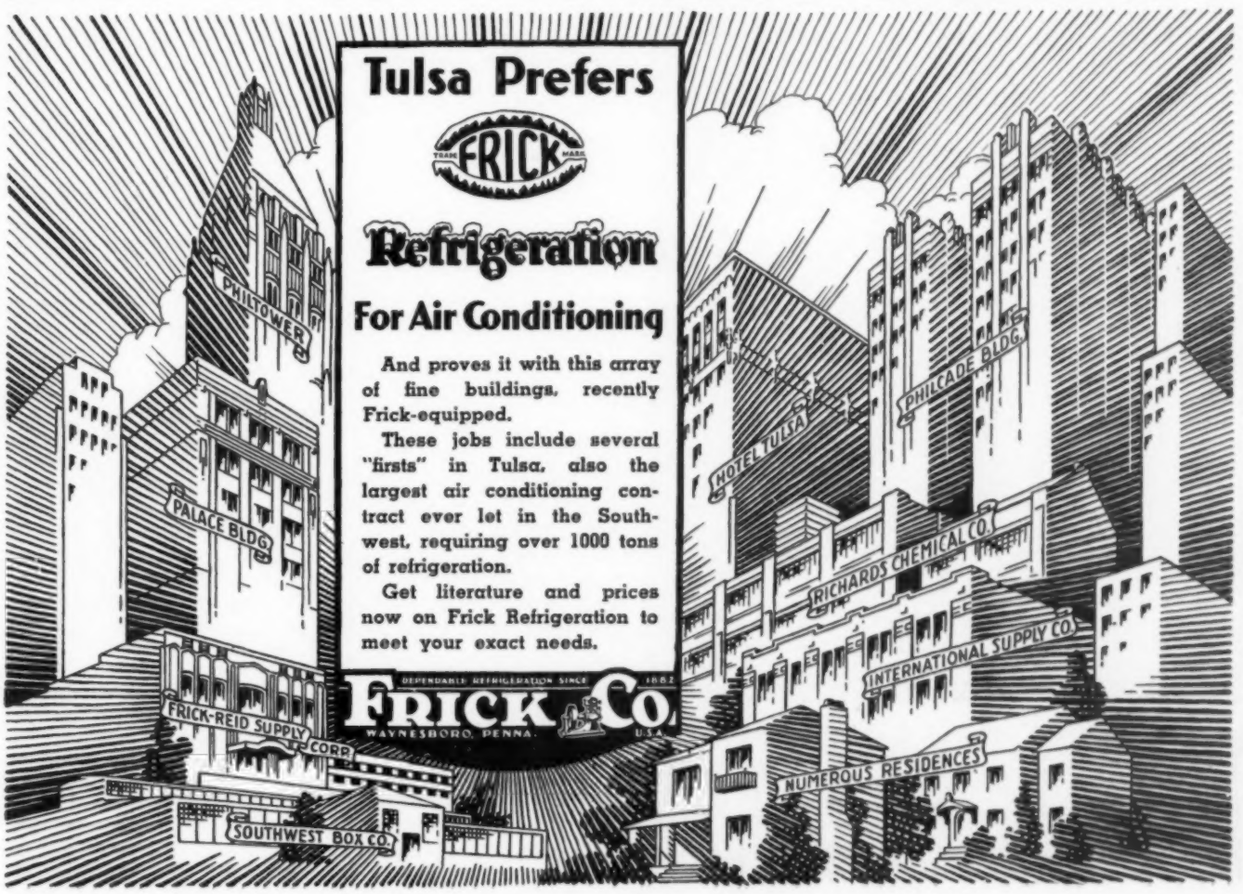
THE T. T. SMOKE GUN

Uses the same chemical that the United States Navy employs when laying down a smoke screen, or the air pilot who writes cigarette advertisements in gigantic letters of white against the blue background of the sky.

Simple . . . Inexpensive . . . Harmless . . . Valuable in tracing air currents, determining the direction and velocity of air flow, and the general behavior of either warm or cold air in conditioned rooms, etc. Useful and time saving in balancing installations.

PRICE, in suitable carrying case with 3 refill capsules and complete instructions **$12.50**
(One reloading capsule will produce 1000 puffs of dense white smoke.)

E. VERNON HILL
179 W. Washington St.—Chicago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FRICK
Refrigeration
For Air Conditioning
And proves it with this array of fine buildings, recently Frick-equipped.
These jobs include several "firsts" in Tulsa, also the largest air conditioning contract ever let in the Southwest, requiring over 1000 tons of refrigeration.
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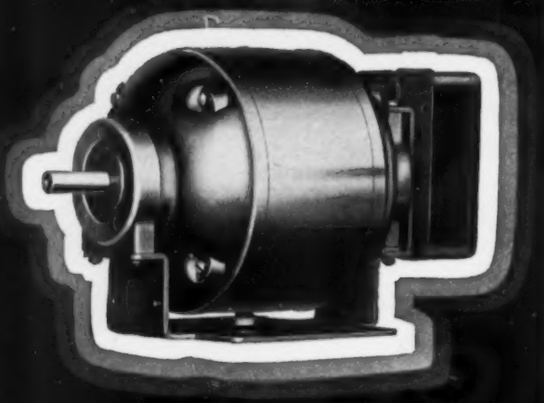
NUMEROUS RESIDENCES

BALDOR BUILDS *Better Motors*

for *extra* QUIET OPERATION



The NEW
BALDOR
(GIMBAL CUSHIONED)
MOTOR

It's QUIET – both electrically and mechanically. Scientifically rubber mounted to dampen vibration and provide the utmost in Quiet Operation.

Available in both Split Phase and Condenser types – large and small sizes.

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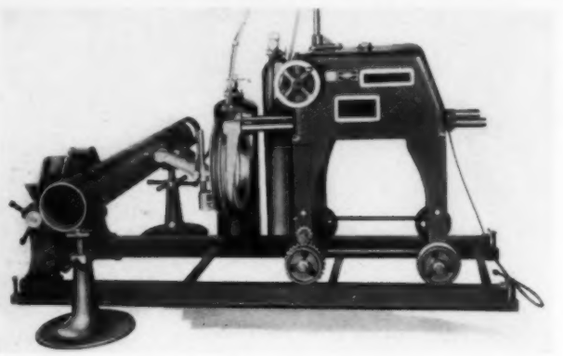
BALDOR
A BETTER MOTOR

require the use of cams, templates or special fixtures. It is claimed by the maker that the surface it produces has the appearance of a lathe tool cut.

The cutting torch is guided by a mechanism which duplicates the motion of a torch held in the operator's hand. It will cut pipe from 2½ to 12 in., making tees, reducing tees 90 deg, branch reducing tees 45 to 90 deg, elbows, miters, Y's and blunt bull plugs, as well as hole cutting. The case containing the gen-

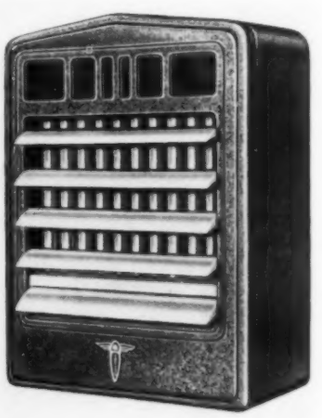


erating mechanism is mounted on four legs which are equipped with flanged wheels running on a track. The pipe is centered in a vise and supported on roller pipe rests, if the length requires the additional support, for straight cutting for butt or tee welding, and the adjustable torch carrier brought in the proper position. If a hole is to be cut in the pipe, it is placed at right angles to the torch carrier, on the roller pipe rests.

The settings of the generating mechanism are regulated by positioning a rotating beam or lever which operates a reciprocating slide. The beams are marked to show the settings for the various sizes and types of cuts.—Oster Mfg. Co., 2057 E. 61st Pl., Cleveland, Ohio.

Gas Fired Unit Heaters Redesigned

No. 1335 — Complete new line of "Janitrol" gas fired unit heaters comprises seven sizes ranging from 45,000 to 200,000 Btu hourly input. The units are styled to meet the modern trend with offset front panel and rounded corners. Casing finish is blue crackle baked enamel and air louvers are aluminum.



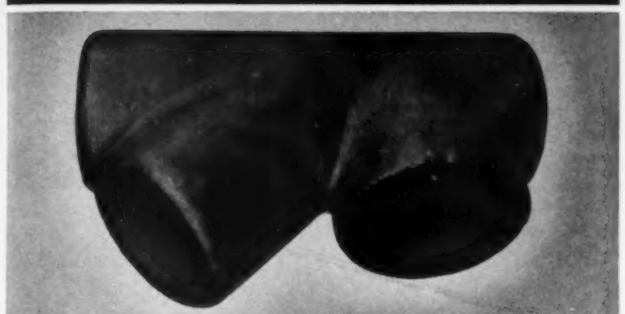
A new quiet style of fan has been adopted, and many design and construction features, heretofore regarded irrelevant have been modified to reduce noise, the maker states.—Surface Combustion Corp., 2375 Dorr St., Toledo, Ohio.

Offers New Pump for Deep or Shallow Wells

No. 1336—New vertical, close coupled motor driven centrifugal pump for general service in deep or shallow wells has been designed to meet the need for a small diameter, low capacity pump with low initial and operating costs. It is suitable for economically pumping water under either high or low pressure at 6 to 60 gpm.

Because of compact construction, only a small space is needed

INCREASE AIR-CONDITIONING EFFICIENCY WITH **CORK**



SPECIALLY FABRICATED FITTING COVERS MADE TO FIT ANY PIPING ARRANGEMENT

WELDING ELL COVERS (90 AND 45) MADE TO FIT ALL MAKES OF METAL WELDING ELLS

WHEN cold lines are insulated with Novoid Cork Covering, air conditioning systems operate more efficiently and economically. Properly installed on cold water risers and return lines, Novoid helps maintain uniform water temperatures. Heat cannot penetrate its unique cell structure. Condensation cannot form on its moisture-proofed surface.

Novoid Cork Pipe Covering and Cork Fitting Covers are available in a complete range of standard sizes. For special fittings, Novoid Fitting Covers can be fabricated to order, saving erection time and the cost of separate fittings which may have to be cut down and altered on the job. Novoid Welding Ell Covers (90° to 45°), are made to fit all makes of metal welding ells—long or standard radius. Light weight, ice water thickness is adequate for temperatures above 35° F., and reduces weight on the line and hangers. Application cost is relatively low because the covers are fabricated ready to apply. For full information, get in touch with our nearest branch or write Cork Import Corporation, 330 West 42nd Street, New York City.

BRANCH OFFICES: Chicago, 400 West Madison Street; Boston, 248 Boylston Street; Philadelphia, 1524 Chestnut Street.

NOVOID CORK PIPE COVERING

SEE OUR EXHIBIT, BOOTH 337, AT THE 5TH INTERNATIONAL HEATING & VENTILATING EXPOSITION, GRAND CENTRAL PALACE, NEW YORK, JANUARY 24-28, 1938.

EXPANSION VALVES in Bullock's New Air Conditioning System

A-P Expansion Valves shown on section of Air Conditioning unit installed by Western Air and Refrigeration, Inc., Los Angeles, Cal.

Go to Your Jobber for Your Controls..

In the largest Air Conditioning Installations in the Country, as well as in the smaller ones, you'll find A-P Valves invariably specified.

Refrigeration and Air Conditioning experts know that every A-P Expansion Valve must prove over and over again, *before it leaves the factory*, its leakproof construction, its accuracy under extreme conditions, its dependability.

To install A-P Controls of any kind is always definite assurance of satisfactory operation — a satisfied user.

Progressive Jobbers Everywhere Stock A-P Controls

No. 73RB Solenoid

No. 210 Expansion Valve

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AUTOMATIC PRODUCTS COMPANY

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This tag—wired to the handle of every genuine "TRIMO-ALLOY" tool—is your assurance that you are buying the strongest, safest pipe wrench ever made—yet "TRIMO-ALLOYS" COST NO MORE.

LOOK FOR THIS *Written Guarantee* WHEN BUYING PIPE WRENCHES

It is your assurance of 100% Heavy Duty Alloy Steel construction—drop forged and heat treated for extra strength—AT NO INCREASE IN PRICE!

DROP FORGING PROCESS

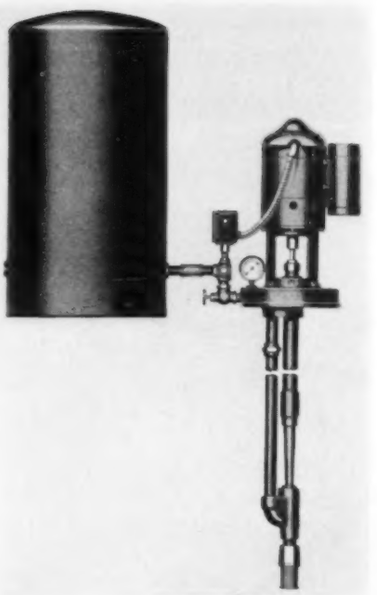
The strongest known method of making quality steel tools—and the reason for the "built-in" quality which permits Trimo to guarantee the WHOLE WRENCH.

TRIMONT MFG. CO., INC., Roxbury (Boston), Mass.

"TRIMO

Guarantees The WHOLE Wrench"

for installation, an important feature where floor space is limited, the maker states. No lubrication is necessary, and there are no mechanical moving parts below ground.

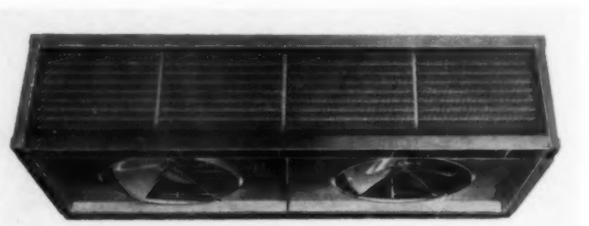


Units for shallow well service consist of combined motor, pump and base, into the bottom of which is screwed a single suction pipe extending below the water level. This is satisfactory for water lifts of 15 to 20 ft. Pumps for deep well—20 to 200 ft deep—are equipped with an ejector and venturi in one of two drop pipes extending from the pump down into the well. This pump operates on the principle of the centrifugal pump, with the ejector added to lift water from depths beyond that from which a centrifugal pump alone will lift it. By allowing a predetermined amount of water from the pump discharge to bypass down one of the drop pipes in the well and back up through the ejector into the venturi, a vacuum is created above the ejector nozzle, drawing well water into the suction chamber. The high velocity of the water through the venturi, and the mixing of the two streams of water, lifts the well water to within reach of the pump suction.

The illustration shows an ejector centrifugal pump for deep well service with pressure tank and automatic controls.—Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill.

New Unit Heater Has Multiple Fans

No. 1337—Like the recently announced single fan "Projection" unit heater, new "Multiple Projection" heater utilizes a new means for both diffusing the air stream and carrying it a considerable distance at the same time. With this ceiling mounted unit, warm upper air is drawn through the two coils and then



projected straight downward in a vertical stream. As this air stream enlarges it induces room air which both gives it volume and so reduces its velocity that it reaches the floor evenly and comfortably, says the maker.

This heater is primarily designed and intended for use where a maximum of space must be heated with a minimum of units. It consists of two extended surface coils contained within a metal casing. The motors are mounted out of the path of the air on a resilient construction. A new four blade propeller fan, especially designed for quiet operation, is employed. The heater is available with two, three, or more fans.

For all practical purposes the mounting height of this unit is almost unlimited, according to the manufacturer.—Trane Co., La Crosse, Wis.

Insulating Ducts Made Easy

Much has been said and written about duct insulating materials for the new and fast growing Air Conditioning industry both with reference to large and small jobs.

Many materials have the necessary qualifications, however, they are impractical to apply and handle on the job, running up many times high labor costs in addition to the material cost. Many of these materials were designed for purposes other than duct insulation but have "after a fashion" been used as a duct lining or insulation.

There is a new material now on the market which has been designed and built throughout exclusively for the lining and insulating of ducts. This material is known as Asbestos Protected Dux-Sulation. The producers of Dux-Sulation have for many years been identified with the Heating and Air Conditioning industry and are furnishing other forms of insulation for other specific requirements.

The sound absorption efficiency as determined by the Riverbank Laboratories of Geneva, Illinois, rate Dux-Sulation at 61% efficient. The thermal conductivity is K .27 B.T.U., which gives it a 70% insulating efficiency.

The speed in application comes through the fact that Dux-Sulation is furnished in a unit package form consisting of a roll of the insulating felt 36" wide containing 100 Square Feet and also a special waterproof Adhesive for applying the insulating material to the duct and an Asbestos Protected Tape for covering the corners and joints. The Dux-Sulation Felt itself has built into it an Asbestos Protected plate.

The manufacturer points out that the applying of insulating material is at the best done under inconvenient and hard working conditions, that is, it is applied from scaffolding and is often carried up through hatchways, staircases, windows and on ladders. This makes the handling of large, rigid sheets difficult and in many cases impossible.

It is obvious that taking a roll weighing about 40 lbs. is the most convenient way.

Dux-Sulation is a very tough but flexible blanket. It is cut with snips or a knife and, as mentioned before, comes complete, there being no other accessories such as wire, cleats, screws or bolts necessary.

This insulating felt in addition to its Asbestos Protected top is finished in an attractive pattern and colored a neutral brown shade so that no further decorating or painting is necessary.

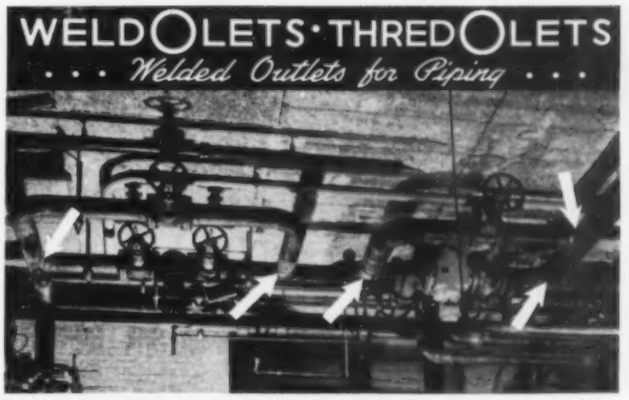
In the application of this new material the body of the felt is never penetrated and because it is applied with a special adhesive, there is no possibility of chipping or rupturing the insulation. It cuts to a clean edge and fits snugly to flat, curved or round surfaces and, therefore, is not bulky but makes a neat tailored job. No plastic cements need be mixed for the irregular surfaces and one uniform insulation is used throughout.

Where this Dux-Sulation is to be applied to the inside of the ducts, it is pointed out that it may be cemented first to the flat sheets of steel before they are put in the brake and formed into ducts.

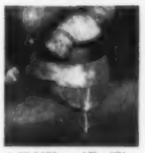
Since Dux-Sulation was developed after a careful study had been made of all the industry's requirements and of all other insulating materials being offered, it answers the need for an especially designed material for duct work.

Dux-Sulation is a product of Grant Wilson, Inc., 4113 W. Taylor St., Chicago, Ill.

Advertisement



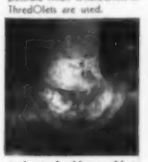
Branch Outlets on this job were made without cutting or threading the main pipe



1. WeldOlets and ThredOlets are easily installed. Simply select the position of the outlet, mark center lines and tack the fitting into position.

2. Then weld by oxy-acetylene or electric-arc method. A leak-proof joint of full pipe strength is obtained.

3. On 2" outlets or larger, the button is removed after installation. A full inspection of the inside of the joint is possible when WheldOlets or ThredOlets are used.



4. A simple Vee weld is used for attaching the branch when WeldOlets are used. If ThredOlets are used, the branch is screwed into position.

ENGINEERS, contractors and others responsible for efficient piping installations have long recognized the shortcomings of threaded piping installations. Bonney WeldOlets and ThredOlets make it possible to install branch pipe lines *without cutting, threading or fitting* of the main pipe. Absolutely leak-proof joints are obtained. The heavy external rib compensates for loss of strength in the main pipe when the hole is cut and their wide base reduces bending stresses to a minimum. Their funnel-shaped outlets increase free flow conditions, reduce turbulence and friction, yet they cost no more to buy and less to install than ordinary fittings. They are equally well adapted to new construction and for all maintenance work.

The many advantages of WeldOlets and ThredOlets are obvious upon inspection. To show them to you, we'd like the opportunity of sending you a sample fitting—without obligation on your part, of course.

Simply sign and attach the coupon below to your letterhead, and we're confident you'll use them on your next piping job.

Bulletin WT23 tells How, When, Where and Why to use WeldOlets and ThredOlets. Mail coupon for your copy.

BONNEY FORGE & TOOL WORKS

Forged Fittings Division

Allentown, Pa.

Stocked by Leading Distributors

Send me a sample WeldOlet and a copy of Bulletin WT23 giving all their advantages. HPAC-117

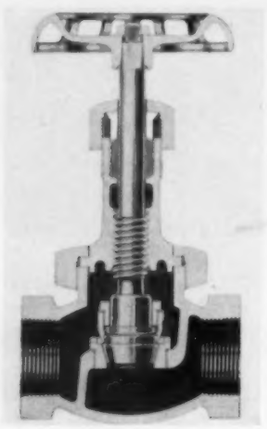
Name.....

St. & No.....

City & State.....

Plug Type Valve Seat Is of Stainless Steel

No. 1338—Plug seat valve announced last month features a plug and seat ring made of stainless steel having a Brinell hardness in excess of 500. Valve is specially recommended by the makers for severe service such as continuous throttling for pressure reduction or free blow duty such as soot blowers, injectors, heating coils, or any steam line where close regulation is required. It is stated that this plug and seat practically nullify wear and almost entirely eliminate danger of wire drawing and cutting.



In a folder on this valve, the makers answer the question "How hard is 500 Brinell?" by comparison with the hardness of some substances that get into pipe lines. They list boiler scale, pipe chips, welding heads, rust tubercles and iron oxides as under 500 Brinell, therefore not able to scratch the new valve seat. By contrast, a common nail is shown to be under 200 Brinell hardness.—Jenkins Bros., 80 White St., New York, N. Y.

Angle Flow Valve for Hot Water Heating Announced

No. 1339—Announcement of a new water circulator has been followed with an angle flow valve to round out a line of controls for improving circulation on hot water heating systems. By installing one of these systems, an unlimited amount of domestic hot water is available, the year around, distribution is equalized and circulation is improved, the maker states.

The angle flow valve acts both as a flow valve and elbow at the same time, and an additional flow valve is not required in a single return system. Improvements include a new valve disc construction that balances the pressure head to assure against leakage from gravity circulation. Larger sizes of these valves are included with flanged ends in order to facilitate rapid installation and replacement. The material of the valve body is brass for the 1 in. size and cast iron for the 1½ and 2 in. sizes with brass trim for all sizes.—Minneapolis-Honeywell Regulator Co., 2701 Fourth Ave., S., Minneapolis, Minn.

NO SMALL MATTER, the additional factor of fire-safety . . . when lining air-conditioning ducts for sound absorption! Bulletins from the National Board of Fire Underwriters report cases where expensive damage was caused by the absence of this protection.

To make sure *your* air-conditioning ducts will never contribute to fire spread, line them with Johns-Manville Airacoustic Sheets. This material has a rate of sound absorption as high as 80% . . . and provides a high degree of fire-safety as well.

Moreover, J-M Airacoustic Sheets provide many other advantages. Permanence, by virtue of their mineral composition . . . resistance to moisture . . . low thermal conductivity . . . light weight . . . and a smooth surface that means low frictional resistance.

For complete details on J-M Airacoustic Sheets, write Johns-Manville, 22 E. 40th St., New York, N. Y.

JM

JOHNS-MANVILLE
AIRACOUSTIC SHEETS
For Duct Lining

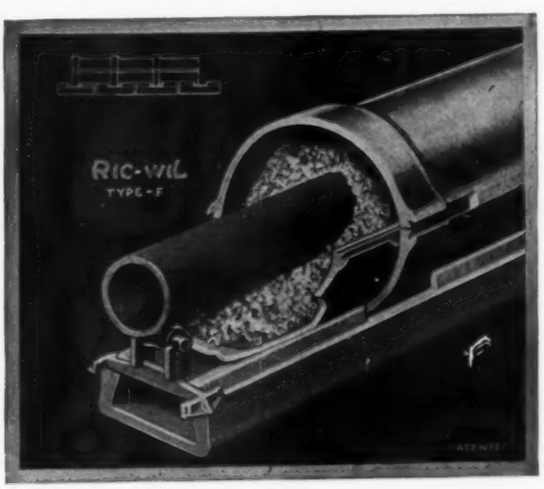
INTERESTED IN A CARDBOARD HOUSE?

THE building customs of the old Orient employed very flimsy materials and construction. But Time and Mother Earth's indigestion, earthquakes, are teaching these people the value of substantial materials and sound American engineering. Heating and power engineers have learned that it is likewise folly to encase underground steam lines in *makeshift* conduit. Unless both materials and engineering practice are of the highest type, Time and natural elements will soon dissipate your conduit investment. A modern Ric-wiL Tile or Cast Iron Conduit System, with incomparable Dry-paC Insulation, is as far ahead of Underground Steam 20 years ago as today's skyscraper is of mud-bamboo-paper houses.

Ric-wiL Tile or Cast Iron Conduit is a complete, correctly engineered system, including pipe housing, base drain, pipe supports, and insulation. All parts come on the job ready to install. Dry-paC Insulation is standard and provides 90% + efficiency. Sectional pipe covering can also be furnished. Write for latest Bulletin.

The Ric-wiL Co., Union Trust Bldg., Cleveland, Ohio
New York San Francisco Chicago
Agents in Principal Cities

Standard Ric-wiL Conduit is assembled on the job—all materials and workmanship are absolutely open to inspection.



REGISTERED IN U. S. PATENT OFFICE

RIC-WIL

CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

This UNIVERSAL PILLOW BLOCK mounts in any position

like this...

Now you can use one pillow block where formerly many different types were required. This revolutionary pillow block is the Randall D. R. O. R. Universal type.

or this...

It can be mounted in any position according to the requirements of each installation. With this pillow block it is only necessary to select the desired mounting position on the job, unscrew the oiler, turn the ball to this position and re-insert the oilcup in a vertical position.

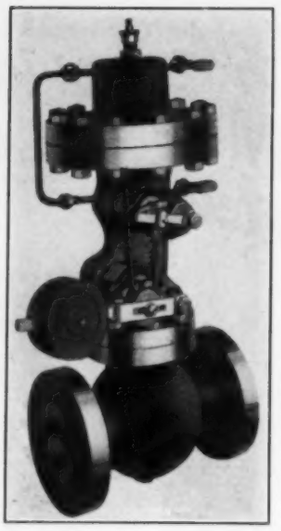
or this!

The Randall Universal Pillow Block, quiet in operation, is self-aligning, self-lubricating and precision-bored. It has the double reservoir oil return which provides large oil supply. This exclusive feature greatly lengthens the life of the bearing. Oiling is only necessary at long intervals. Write for full information.

Cut-away section of ball of Universal Pillow Block showing Double Reservoir Oil Return feature with lower reservoir packed with wool yarn.

Randall GRAPHITE PRODUCTS CORP.
Dept. 1110 609 W. Lake St., Chicago, Ill.

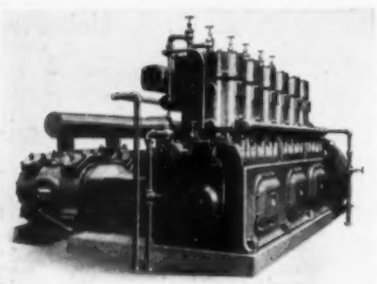
Feedwater Valve



No. 1340—New "Flow-matic" feedwater regulator feeds boiler according to the rate of steam flow and provides the water level characteristics that give best operating results on the individual unit. A higher water level can be provided on heavy loads than on light, or a practically constant level can be maintained for all ratings, the maker states.

This regulator is furnished in all pressure standards from the 250 lb upward. Valves are furnished in 2 to 6 in. sizes inclusive.—Northern Equipment Co., Erie, Pa.

Offers New Gas Engine Compressors

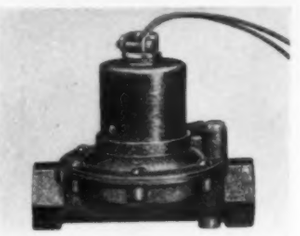


No. 1341 — New compact air and gas compressor unit applicable to special processing needs of refineries and natural gasoline plants, as well as for gas transportation lines, gas or air lift pumping, refrigeration and general compressor services is of the four cycle, angle type.

They are built with one to four compressor cylinders, corresponding to 75 to 300 hp; all compressor cylinders are horizontal and at right angles to the power cylinders. The engine is a vertical, four cycle type, with power cylinders, valves and working parts small in comparison with the slower speed horizontal type of similar horsepower. Large water jackets with clean-out plates are provided.—Worthington Pump and Machinery Corp., Harrison, N. J.

Two Gas Controls Announced

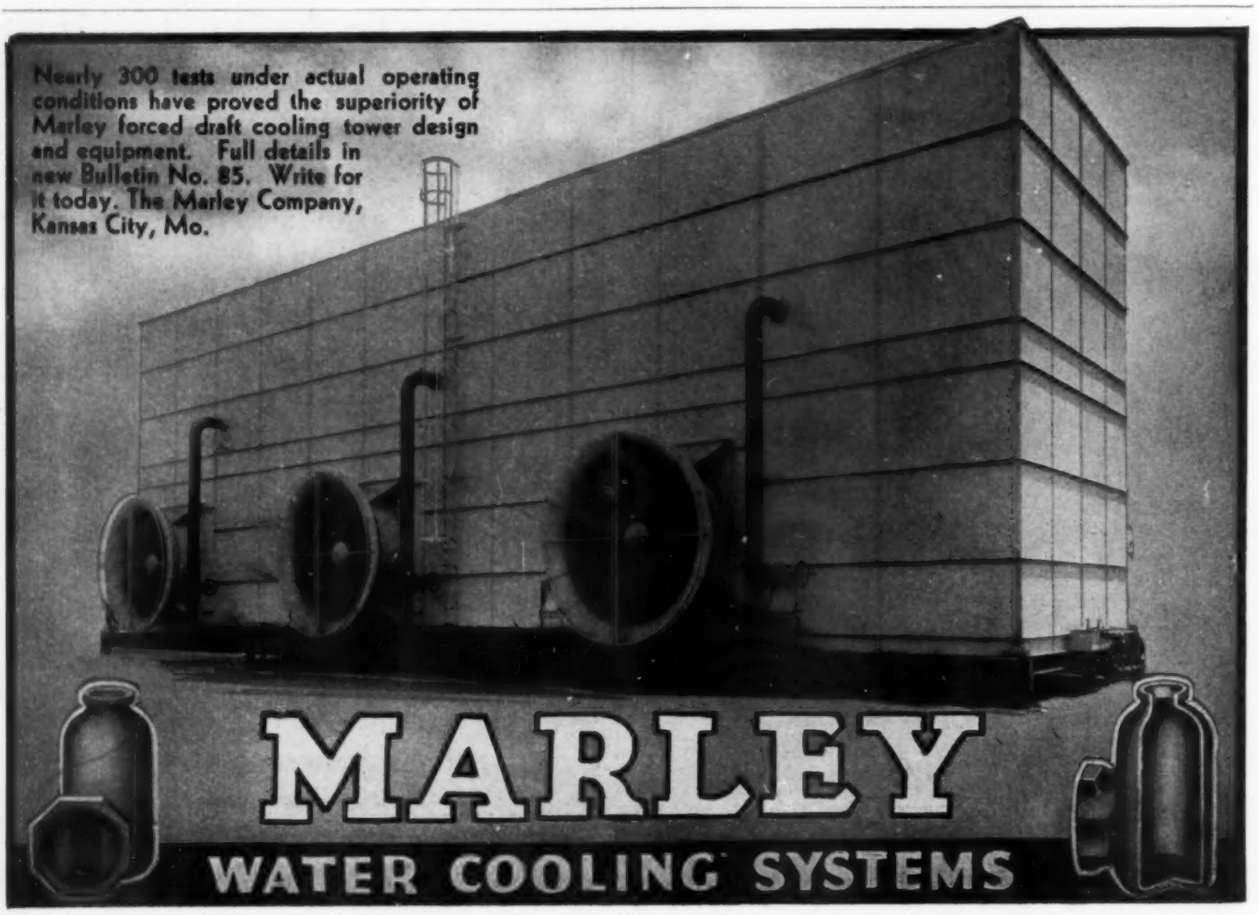
No. 1342—New controls of interest to the gas industry are the "Klixon" electrically operated gas valve and the series of automatic out-pilot shut-off valves. The former combines a disc actuated, rate-of-rise electric head and a diaphragm valve, which operate without hum or flutter, according to the maker. Operating time delay of approximately 30 seconds "off" and "on" is unaffected by ambient temperature changes. Sizes scheduled for production are from ⅜ to ¾ in. I. P. S. with capacities of from 100,000 to 195,000 Btu per hr. Thermal head draws 9 watts, and is available for 12 volts or 110 volts a-c.



The series of out-pilot shut-off valves combine a pilot burner and a snap-acting disc operated main valve in integral assembly. Should the pilot go out, the main valve snaps shut. Sizes to be manufactured run from 30,000 to 75,000 Btu per hr, with a variety of connection tappings in continuous or 100 per cent shut-off types.—Spencer Thermostat Co., 34 Forest Ave., Attleboro, Mass.

Adds to Line of Portable Pipe Machines

No. 1343—New addition to "Tom Thumb" portable pipe machines rounds out a line of ½ to 2 in. models.


Nearly 300 tests under actual operating conditions have proved the superiority of Marley forced draft cooling tower design and equipment. Full details in new Bulletin No. 85. Write for it today. The Marley Company, Kansas City, Mo.
MARLEY
WATER COOLING SYSTEMS

Just Move This Post

On your RIDGID No. 65R and Avoid the Bother of Changing Chaser Dies

No more waste of time looking for different size dies when you want to thread 1", 1¼", 1½" or 2" pipe if you have a RIDGID No. 65R. Simply move the setting post to the pipe size you want. One set of dies instead of 4 sets — one-fourth the bother.

You'll like the new-style workholder, too. Twist the gauge ring to pipe size, put on the pipe, tighten one screw — quick and easy.

Thousands have found also that this new No. 65R cuts clean accurate threads in all variations, all kinds of pipe. It's a time, temper and money saver.

For more profitable work with less effort, get one of these threaders at your Jobber's.

The Ridge Tool Co., Elyria, Ohio, U. S. A.

What? No Repairs?

With RIDGID Pipe Wrenches, practically none. Housings guaranteed not to break or warp — stops fully 75% of your wrench troubles.

RIDGID PIPE TOOLS

AS OTHERS SEE US

In a recent survey to determine the attitude of motor buyers toward the leading makes, some very enlightening facts were discovered.

In all cases where the Leland was among the makes considered, it was "in the money" on all the following counts:

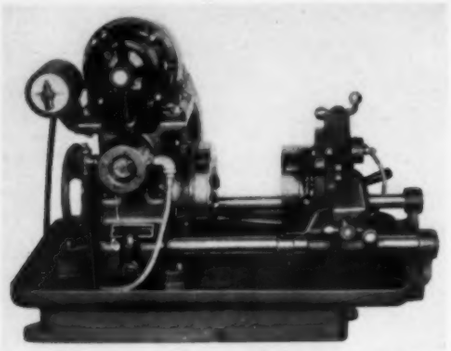
- Design and engineering service
- Field service
- Delivery service
- Dealer acceptance
- User acceptance
- Design features with special sales appeals.

Investigate the Leland motor. It belongs on YOUR appliance.

THE LELAND ELECTRIC COMPANY
DAYTON, OHIO

Canadian Address Toronto — Cable Address Lelect

Equipped with a new type die-head which is integral with the carriage, the threading dies are more rigidly supported and their life lengthened, says the maker. In addition, more accurate work is produced. The die-head is of the front-cutting type which together with the machine's "close-grip" front chuck, makes it



possible to handle pieces as short as 2½ in. without using a nipple chuck. The size setting marks are on top of the head, where they are plainly visible for easier, more accurate settings.

An internal oiling system to the dies and cut-off tool is provided. A flexible hose carries the oil from the oil pump to the intake valve in the die-head and the flow of oil is controlled by a two-way thumb valve conveniently located for the operator.

The holder for the cut-off, and reaming and chamfering tools is operated in a heavy block by a large ball-crank. This rectangular tool holder is designed to eliminate twist and breakage of the tools. In addition, the cut-off and reaming and chamfering tools are heavily constructed.

Overall length of the new machine is 34 in., width 21 in., height 24 in., and net weight 375 lb.—Oster Mfg. Co., 2057 E. 61st Pl., Cleveland, Ohio.

Cutting Oil Has Antiseptic Quality

No. 1344—Preventing the risk of infection, a new antiseptic quality is present in "Ridgoil," according to an announcement by the maker of this sulphur base cutting oil.

Besides this antiseptic quality, experiments have shown it to be highly satisfactory for cutting smooth clean threads on iron, steel or brass pipe, the manufacturer adds. It penetrates quickly, cools and lubricates, and will not congeal above 20 F.—Ridge Tool Co., Box 670, Elyria, Ohio.

Producing Pipe Nipples

No. 1345—The Chicago Nipple Mfg. Co., Chicago, Ill., is now producing "Toncan" iron nipples under the trade name of "Blue Ribbon Toncan" nipples, according to an announcement by Republic Steel Corp., Cleveland, Ohio.

Solenoid Valves Open Against High Pressures

No. 1346—Improved valves (known as "K-10") have a new high-powered solenoid and a lever action which multiplies this power more than six times, according to the maker. With this feature, these valves will open dependably against line pressures as high as 140 lb, which makes the valve applicable to the control of steam, air, water, and gas at high pressures as well as viscous fluids such as fuel oils as heavy as No. 6 at room temperatures. Valves close with the line pressure on top of the seat to insure tight shut-off.

Jointite TRADE MARK CORK INSULATION

Section of "Jointite" Moulded Cork Pipe Covering, with moulded fitting cover. Made of 100% pure Cork, sealed with special finishes to keep out moisture.

For
AIR CONDITIONING

Economical and precise temperature control can be obtained for users of air conditioning through "Jointite" Cork Insulation. Ask us now for full information about this dependable insulator for all low temperature lines and ducts. Details and specification data on request.

MUNDET CORK
CORPORATION
450 SEVENTH AVE., NEW YORK, N. Y.
OFFICES IN THE PRINCIPAL CITIES

for STRAIGHT LINE COMFORT

Sub atmospheric Steam

• • • MEETS THE CHANGING CONDITIONS OF WEATHER BY CONTINUOUSLY CIRCULATING STEAM AT TEMPERATURES CORRESPONDING TO THE VARIABLE RANGE OF PRESSURES ABOVE AND BELOW ATMOSPHERE

DUNHAM *Differential* HEATING

HEATING

Prior to 1927 winter temperatures could only be partially met with "pressure" steam. The resultant overheating, not evident during base-temperature weather, was most obvious during the major part of the heating season when heating weather was 30 to 40 degrees above the base-temperature.

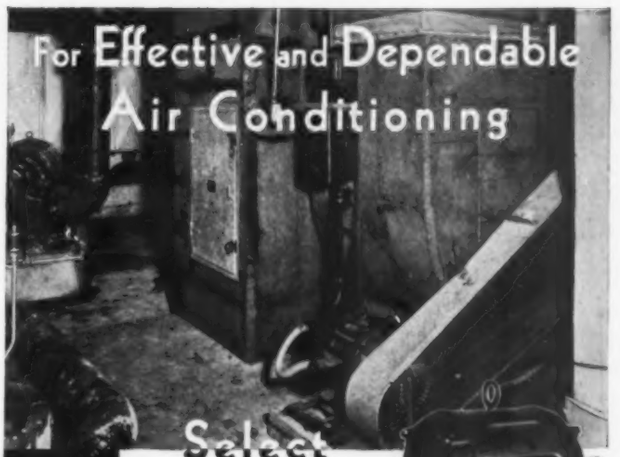
DUNHAM SUB-ATMOSPHERIC STEAM HEATING rendered such systems obsolete. Through it, either manually or automatically, it is possible to circulate over a range of more than 75 degrees, steam no higher or lower in temperature than required to maintain desired room temperature. Thus, without window cooling, without added appliances, without radiator valve manipulation, it is commonplace to provide straight line comfort regardless of weather vagaries. Naturally the production of "cool" steam is less costly.

The brochure "Cool Steam" is an interesting examination of Possibilities of Sub-atmospheric Steam Heating. May we send it to you?

Consult the Architect for good design and the Consulting Engineer for mechanical equipment.

C. A. DUNHAM COMPANY

450 EAST OHIO STREET, CHICAGO



REPULSION-START-INDUCTION
SPLIT-PHASE
CAPACITOR-START
SLIP-RING
SQUIRREL-CAGE
CAPACITOR-RUN
REPULSION-INDUCTION
SHADED-POLE FAN MOTORS
MULTI-SPEED POLYPHASE
FYNN-WEICHSEL SYNCHRONOUS
GEAR-MOTORS
MULTI-SPEED CAPACITOR
DIRECT-CURRENT APPLIANCE-TYPE
HAZARDOUS-GAS
DIRECT-CURRENT INDUSTRIAL-TYPE
TOTALLY-ENCLOSED FAN-COOLED
VERTICAL MOTORS
RIGID MOUNTED
ANNULAR RUBBER MOUNTED

Select the Proper Wagner Motor For the Job

Dependable, economical and efficient operation of any air conditioning installation depends largely upon the reliability and performance of the electric motors that drive the equipment. Consequently, manufacturers and contractors who recognize the value of dependable and sturdy motors for their air conditioning installations specify Wagner motors to solve their drive problems. They know that the selection of the correct Wagner motors helps their equipment to give better, more dependable, more economical, and more efficient service.

Wagner builds all types of motors generally applied on air conditioning machinery, making it possible for you to choose motors exactly suited for your installations. Wagner motors are available with proper mechanical and electrical characteristics to fit the varying requirements of compressors, pumps, air-movement devices, and all types of ventilating equipment.

The above picture illustrates a typical air conditioning application using Wagner motors. A Wagner 7½-hp type RP polyphase squirrel-cage motor is belt-connected to the air conditioner in the basement of a large department store in Texas.

On your next air conditioning design or installation problem—consult Wagner. Wagner's experience will be helpful to you. Send for descriptive literature today.

ML437-1L

Wagner Motors

Wagner Electric Corporation
6400 Plymouth Avenue, Saint Louis, U.S.A.

MOTORS TRANSFORMERS FANS BRAKES

READY NOW
ENTIRELY NEW CATALOG

Send Today for Complete Engineering Data

on Industrial Spray Nozzles—Atmospheric Spray Cooling Towers—Induced Draft Cooling Towers and Forced Draft Cooling Towers.

BINKS MANUFACTURING COMPANY
3114-40 CARROLL AVE. CHICAGO

Statement of Ownership and Management of "Heating, Piping and Air Conditioning" for October 1, 1937

The following is a statement of ownership, management, etc., as required by the Acts of Congress of August 24, 1912, and March 3, 1933, of "Heating, Piping and Air Conditioning," published monthly at Chicago, Ill., for October 1, 1937:

State of Illinois, County of Cook, ss: Before me, a Notary Public in and for the State and county aforesaid, personally appeared F. P. Keeney, who, having been duly sworn according to law, deposes and says that he is the business manager of "Heating, Piping and Air Conditioning," and that the following is, to the best of his knowledge and belief, a true statement of the ownership and management of the aforesaid publication, for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are:

Publisher, Keeney Publishing Company, Chicago, Illinois.
Editor, C. E. Price, Chicago, Illinois.
Managing Editor, C. M. Burnam, Jr., Chicago, Illinois.
Business Manager, F. P. Keeney, Chicago, Illinois.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

Keeney Publishing Company, 6 North Michigan Ave., Chicago, Illinois. Stockholders: F. P. Keeney, Chicago; W. J. Osborn, Fairfield, Conn.; R. Payne Wettstein, Chicago; Chas. E. Price, Chicago; Robert A. Jack, Cleveland Heights, Ohio.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge, and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

F. P. Keeney,
Business Manager.

Sworn to and subscribed before me this 22nd day of September, 1937.
[My commission expires Feb. 10, 1938.] Grace E. Waymire.
(SEAL) Notary Public.

Approved by Underwriters' Laboratories. Solenoids are removable without removing the valve from line pressure. Coils are waterproof. Terminal connection rotates for ease in wiring. Port sizes are from $\frac{3}{32}$ to $\frac{7}{16}$ in.—General Controls Co., 267 Fifth Ave., New York, N. Y.

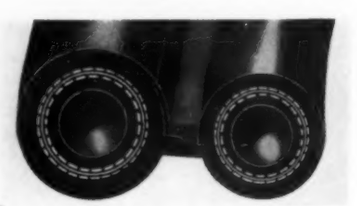
Unit Heaters Have New Housings

No. 1347—Stating that it is one of the most important developments since they began the manufacture of the "Thermolier" unit heater, the makers have announced the "de luxe" type, which was created by leading industrial designers for unit heater installations where appearance is a major factor.

The new unit embodies the heating unit of the industrial and factory types, in a modern housing finished in crackle black and satin chrome. Heat distribution has been improved by new angular louvers which provide widespread heat flow. Inlet and outlet pipes have been relocated at the rear and the specially-designed motor and fan are concealed. Among its features are the internal cooling leg, which continually drains condensate to keep the entire heating surface effective at all times. Recommended by the maker for installation in stores, shops, offices, lobbies and similar places.—Grinnell Co., Inc., 260 W. Exchange, Providence, R. I.

Combines Air and Fluid Hose

No. 1348—A new development in spray painting hose is the "du-al" hose, which combines air and fluid hose in one unit, the tubes being united by a web of solid rubber which is molded in one piece with the outer casing of the hose.



For making standard connections, enough of the web is removed to spread the hose to the required outlets, further splitting being prevented by a tightly fitting collar. Available with $\frac{3}{8}$ in. fluid passage and $\frac{5}{8}$ in. air passage.—Eclipse Air Brush Co., Inc., 79 Orange St., Newark, N. J.

Duplex Power Pumps Have New Features

No. 1349—New duplex power pumps are offered for oil field service, fire protection and general service requiring pressures up to 800 lb per sq in. and capacities to 187 gpm. Among the features listed by the maker are quiet, efficient herringbone gears to insure a smooth flow of power to the fluid end, with a minimum of vibration, generous crankshaft and pinion-shaft roller bearings to reduce mechanical friction, and an improved line type fluid end.

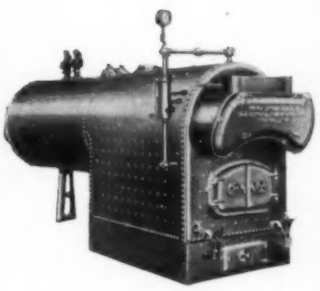
These pumps are offered with a fluid end piston stroke of 10 in. and with cylinder diameters of 2½ to 5 in., providing a capacity range of 40 to 187 U. S. gpm at pressures from 250 to 800 lb. Can be furnished alone, with pulley for belt drive, or with top-mounted motor and silent chain drive.—Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill.

77 YEARS

OF PROGRESSIVE IMPROVEMENT HAVE MADE THE

TITUSVILLE LINE OF BOILERS

- MOST COMPLETE
- MOST EFFICIENT
- MOST ECONOMICAL

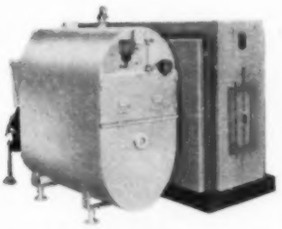


For the modern, economical heat-power unit, inquire about the Titusville "RP" Portable Return Tubular Firebox Boiler line.

Made by one of the oldest and largest manufacturers of all-steel boilers, the Titusville line covers every known power and heating job from small residence boilers to giant water tube units.

Whatever may be your boiler requirement, you can depend implicitly on Titusville for time-tried dependability—for modern efficiency and economical operation. Your local Titusville Representative will be glad to cooperate with you.

Titusville Series S-R Compact Type Heating Boiler with self supporting firebox.



TI-SCOT—the oil burning small residence boiler that has everything with 21 important advantages of design.

Special literature available on all types.

The TITUSVILLE IRON WORKS CO.

Division of Struthers-Wells Titusville Corporation

TITUSVILLE, PA.

Butler Brothers, Chicago, Ill.

LEADING CHICAGO FIRM GETS IMPROVED HEATING

Famous Butler Brothers Complete Payment After One Season With Webster Moderator System

MEETS VARIED HEATING NEEDS

Chicago, Ill.—The heating installation in the great central warehouse and office building group of Butler Brothers Store was modernized during the early fall of 1935. The previously uncontrolled heating system was orificed throughout to balance distribution and placed under control of an 8-zone Webster EH Moderator System. This number of zones was necessary to provide for different conditions of occupancy and the needs of different tenants as well as the requirements of Butler Brothers own operations.

Butler Brothers Baltimore, Md.

This modernization program, one of the largest central control heating installations ever made, was completed in a remarkably short time by William Lees, Inc., prominent Chicago heating contractors. The fall and winter of 1935-36 served as a period for adjustment and perfection of operating procedure.

An idea of the savings possibilities is afforded by the record for five months during this adjustment period, from January to May, 1936, inclusive. During this period a measured savings of 420.16 tons, equivalent to $1218.46, was attained.

Under the contract covering the modernization program Butler Brothers reserved the option to permit payment to be made out of current monthly savings as made, or to complete payment for cash. It is significant that with this privilege Butler Brothers elected to complete payment for cash early in the second season of operation.

It is even more significant that a similar modernization program has since been carried out in the Baltimore warehouse building of Butler Brothers.

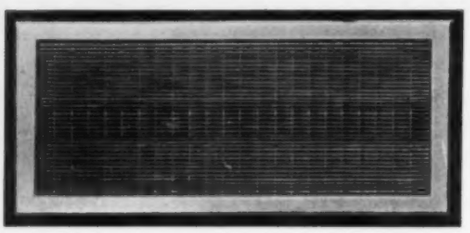
These before-and-after facts point the way to maximum comfort and economy in heating new buildings as well as in modernization of existing installations. Consult your architect, engineer or heating contractor. Or address WARREN WEBSTER & CO., Camden, N. J.

Pioneers of the Vacuum System of Steam Heating
Representatives in 60 principal U.S. Cities—Est. 1888

WEBSTER MODERATOR CONTROL "Control by the weather"

SEE WEBSTER EXHIBIT HEATING & VENTILATING EXPOSITION New York January 24 to 28, 1938

WATERLOO AirMaster GRILLES



Engineered scientifically for accurate, controlled diffusion and direction of incoming air. The exterior bars are set at specified angles; interior supporting bars adjustable individually left and right (number of settings unlimited); 74.4% free area; no raw edges exposed to air flow. New straight-line design harmonizes perfectly with modern decorating treatments. Full details mailed on request. Write

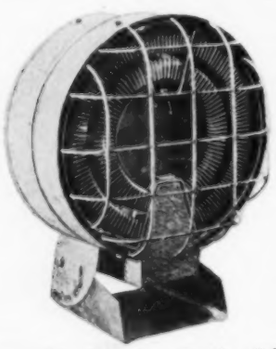
Waterloo Register Co.
Waterloo, Iowa—Seattle, Wash.
In New York City—Air Conditioning Utilities
8 W. 40th St.

Maintain shop comfort this fall and winter, with

CHROMALOX ELECTRIC UNIT HEATERS

Type HF Chromalox Unit Heaters, available in six sizes: 1.5 Kw. to 4.5 Kw.

Far less expensive than firing up the steam heating plant for a few hours heat. Far quicker and easier, too. Close the switch and get heat instantly. Better still, use thermostat control and save power while keeping even shop temperature. These unit heaters are working in shops everywhere to the benefit of personnel health and maintained production.



Type UB Chromalox Electric Unit Heaters. In ten sizes: 2 Kw. to 20 Kw.

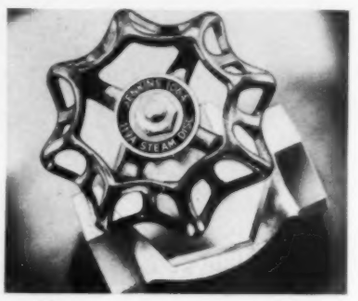
Useful nine months of the year. Chromalox unit heaters are lifesavers in exceptionally severe weather. They also save overtime in the boiler room when some department is rushed, by permitting the boiler room force to quit with the main shop force. Can be installed anywhere a wire can go—no spot too remote or difficult to reach.

Ask the Wiegand engineering staff for aid in providing electric heat for any industrial problem. Send pencil sketch and short description. The 64-page Chromalox catalog and Handbook of Electric Heat, on request.

EDWIN L. WIEGAND COMPANY
7610 Thomas Blvd. Pittsburgh, Pa.

Three Improvements for Bronze Valves

No. 1350—Standard bronze valves have three new features designed to add convenience and better service. A new handwheel design affords large gripping area without bulkiness and because of its deeply depressed center will prevent the hand from touching a hot wheel nut.



A new valve index plate, held in the depressed center of the wheel by the wheel nut, gives the figure numbers of the valve and the disc number and service to aid in ordering replacements.

A new renewable composition disc is also offered with the statement that it has longer life in steam service.—Jenkins Bros., 80 White St., New York, N. Y.

Adds Five Unit Heater Models

No. 1351—Five additional models added to a line of unit heaters brings the total of basic models of the line up to 26. There are now available progressive graduations of 25 E.D.R. from the 75 ft size; 50 E.D.R. graduations from the 450 ft size up to the 700 ft size; and 100 E.D.R. graduations from the 700 ft size up to and including the 1300 ft model. This gives not only a complete range of capacities, but a wide choice of intermediate sizes to accurately and economically fit the requirements of every installation, says the maker.

All the units have rubber mounted motors for isolation of vibration and to contribute to quieter operation. Copper heating elements are made up of streamline tubes with individual convoluted fins and all tubes are silver brazed into cylindrical headers.—Fedders Mfg. Co., Inc., 57 Tonawanda St., Buffalo, N. Y.

Announces New Valve and Controls for Hot Water Heating

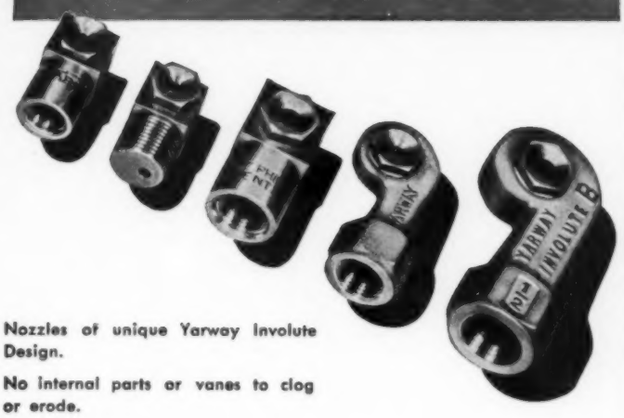
No. 1352*—Illustrated is one unit of a complete new line of electrical controls which includes thermostats, hot water controls, pressure controls, fan controls and relays. The one shown is the immersion type water control. According to the maker,

the line embodies numerous improvements in design and is intended specifically to simplify the purchasing, installation and operation of control equipment.

Also, just announced by the same manufacturer is a new angle type flow control valve for use in hot water heating systems where an angle valve is easier to install. It is made in sizes of 1, 1¼, 1½, and 2 in., the first two having pipe connections screwed both sides and the last two being flanged both sides.

A special feature is the way in which the valve can be opened manually, says the maker. For automatic operation the valve

AIR CONDITIONING NOZZLES



Nozzles of unique Yarway Involute Design.

No internal parts or vanes to clog or erode.

Insure trouble-free air washing service.

Sizes and types for all requirements.

Many large users—installations total more than 5 million gallons per minute in water cooling and air conditioning service. Write for Bulletin N-615.

VARNALL-WARING COMPANY
MERMAID AND ANDERSON STS.
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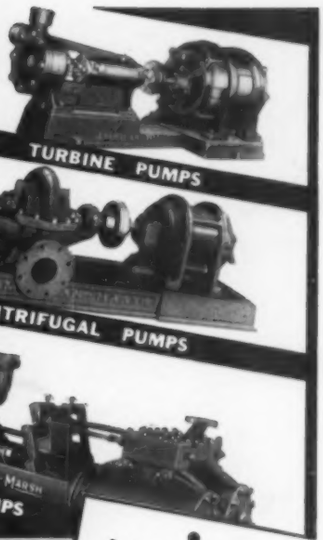
YARWAY

RIGHT TYPE for EVERY SERVICE



Somewhere in this broad line of modern, highly-efficient Turbine, Centrifugal and Reciprocating Pumps is exactly the equipment you need, no matter what your pumping problem. American-Marsh engineers can help you get results with UTMOST economy. We have done it a thousand times before. Write for bulletins.

To better associate our Company name with our long established trade name—American-Marsh—we recently adopted the new Company name used in the signature below.

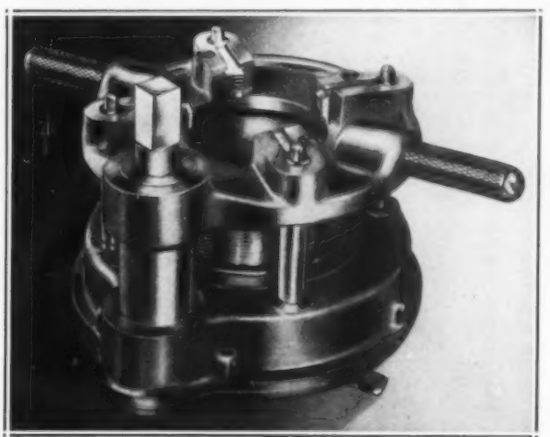
However, there has been NO CHANGE in financial structure, management, or quality standards maintained for over 60 years.

AMERICAN-MARSH PUMPS, INC.
Centrifugal, Turbine, Steam, and Power Pumps
BATTLE CREEK . . . . MICHIGAN

REX-WELD "Super-Service" Vibration Absorbers for AIR CONDITIONING MACHINERY

Stronger walls of uniform thickness and great flexibility make this Rex-Weld Flexible Metal Tubing Unit the ideal absorber for dampening vibration in air conditioning and refrigerating machinery. Produced under Rex-Weld exclusive process, of special alloy bronze. Send specifications for prices.

CHICAGO METAL HOSE CORPORATION
Maywood, Illinois
(CHICAGO SUBURB)



The NEW No. 48-R 2½ to 4"

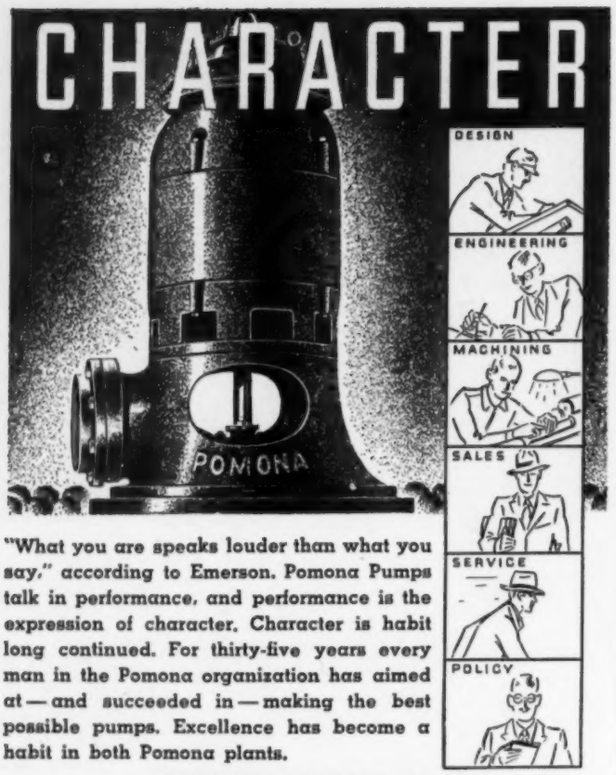
The new Beaver No. 48-R offers five important mechanical improvements in the post-type of geared threader.

1. An extra wide die with wide throat that quickly and easily centers the tool and holds it on the pipe.
2. Fully enclosed gears that save costly repair bills.
3. "Straddle-mounted" driving pinion that makes for long wear and low upkeep.
4. Dies held in position by a dirt-proof spring-backed ball.
5. The "die setting" position is marked by a shoulder on the tapered post—accurate—even under poor lighting conditions.

Weight 58 lbs.,—price $50.00.
Buy it through your supply house.

BEAVER PIPE TOOLS

1137 Keeney Ave. Warren, O.



"What you are speaks louder than what you say," according to Emerson. Pomona Pumps talk in performance, and performance is the expression of character. Character is habit long continued. For thirty-five years every man in the Pomona organization has aimed at — and succeeded in — making the best possible pumps. Excellence has become a habit in both Pomona plants.

POMONA PUMP CO.

Manufacturing Plants: Pomona, California - St. Louis, Missouri
Branch Offices: New York - Chicago - Los Angeles - San Francisco

POMONA TURBINE PUMPS

MONARCH NOZZLES

FOR AIR WASHING

For air washers we recommend either ¼" Fig. 631 (female) or ¼" or ⅜" Fig. 629 (male pipe-illustrated) Brass nozzle. Capacities up to 189 G.P.H. @ 20 lbs.

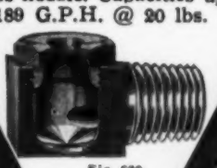


Fig. 629

For air conditioning work, Fig. F-27 is available in same capacities as H-261 and in brass and stainless steel.

For air conditioning work. Supplied in capacities .57 G.P.H. up @ 40 lbs. All brass nozzle.

Fig. F-27

Write for Catalog 6-A

¼" Fig. H-261

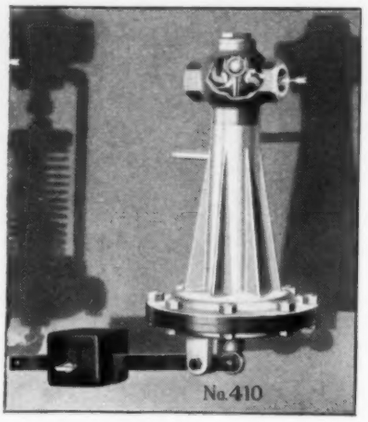
MONARCH MFG. WORKS, INC.

2728 E. WESTMORELAND STREET, PHILADELPHIA, PA.

stem is screwed all the way down; for gravity circulation it is screwed all the way up. This is done by turning the wing extension at the top of the stem with the fingers.—Bell & Gossett Co., 3000 Wallace St., Chicago, Ill.

Three New Reducing Valves Announced

No. 1353—Three new reducing valves recently announced are well adapted to steam heating service as they regulate accurately and close off tight, according to the maker. The spring type model is intended for reduced pressures of 10 to 50 lb, the weight and lever type (illustrated) is for reduced pressures from vacuum to 50 lb, and the liquid column type is suitable for any reduced pressure provided sufficient height is available for the liquid column.

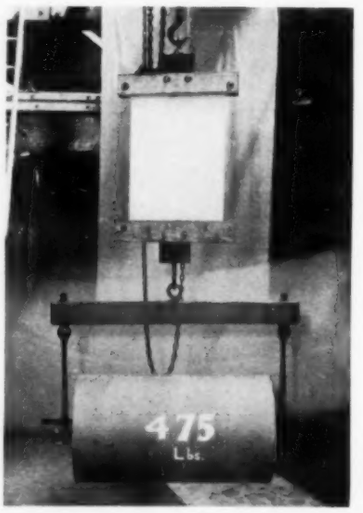


All three are suitable for steam, water, air and similar fluids, and are made in sizes ⅜ to 1½ in. inclusive. They are of the ball type, and according to the maker, have large capacity with low pressure drop due to the tapered form of the opening between the ball and the beveled seat, and to the unobstructed body passages.

Standard construction includes bronze bodies with screwed ends for inlet pressures up to 250 lb. Other castings are semi-steel, and the ball, seat, stem and cage are stainless steel. Union end types may be had and valves with cast or forged steel bodies and "Stellite" seats can be made to order.—Klipfel Mfg. Co., 2651 W. Harrison St., Chicago, Ill.

High Strength Feature of Asbestos Paper

No. 1354—Improved asbestos paper for many uses such as protecting air conditioning ducts, wrapping furnace pipes, etc., features high strength. The illustration shows a small sheet of the paper supporting a weight of 475 lb.



Due to a new waterproofing treatment, the paper also possesses unusual "wet" strength, according to the manufacturer. It has a smooth surface which resists moisture and can be given a paint finish with but one coat of paint.

Furnished in standard rolls 18, 24 and 36 in. wide, weighing 50 lb or 100 lb per roll.—Ruberoid Co., 500 Fifth Ave., New York, N. Y.

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WELD your pipe lines—for added safety and added strength with lighter weight — for smooth-flow interiors — for smooth, sightly, easily insulated exteriors. Taylor WeldELLS head the list of Taylor Forge *Engineered* Welding Fittings. They are reinforced at the crotch where strain is greatest—have tangents which remove the weld from the curved section—have machine tool bevelled welding surfaces which permit sound, dense welds.

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WeldELLS
SEAMLESS PIPE FITTINGS FOR WELDING

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Thousands of Sarco Regulators have been in continuous service for ten years or more. They often save their cost the first month. Unlike any other regulators, Sarcos are operated by liquid expansion—with the Sarco helically corrugated seamless bronze tubing forming a packless seal. Varied types and sizes for hot water, indirect heaters, and air conditioning. 9

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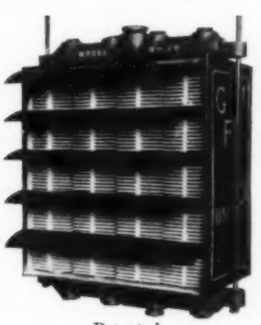

Patented

The "fin" or heating sections are special aluminum alloy, cast metal to metal bonded to cast high-test iron steam chambers, so that no dissimilar metals are in contact with each other and steam—positively eliminating electrolysis that causes corrosion. Neither are there soldered, pressed, rolled or expanded joints, or unions in it—and the fewest connections possible. Maintenance, therefore, is practically nothing. Complete details, capacity tables, engineering data upon request.

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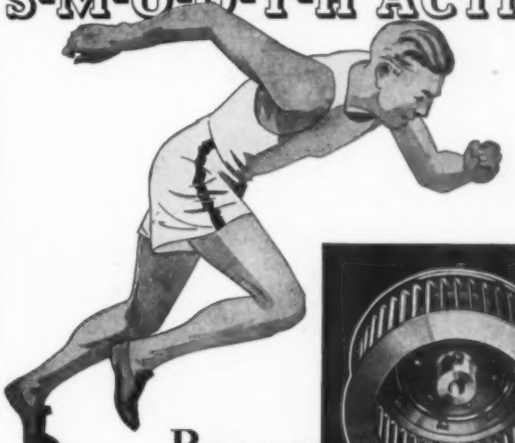

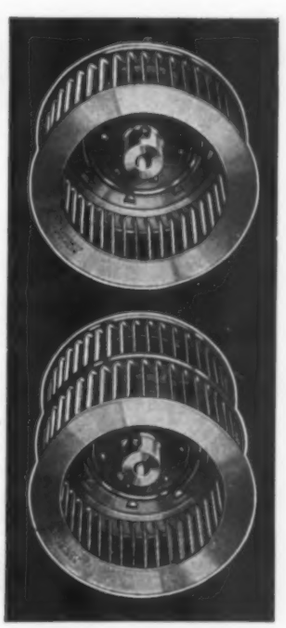

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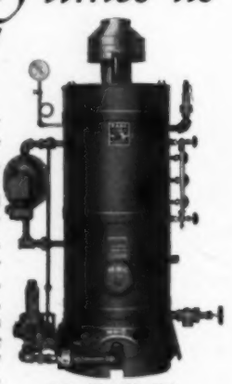

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Conventions and Expositions

American Petroleum Institute: Annual meeting, November 9-12, Hotel Stevens, Chicago, Ill. Headquarters Office, 50 W. 50th St., New York City, N. Y.

International Acetylene Association: Annual convention, November 10-12, Hotel Tutwiler, Birmingham, Ala. Headquarters Office, 30 E. 42nd St., New York, N. Y.

Chemical Industries Exposition: December 6-11, Grand Central Palace, New York, N. Y.

Drying and Air Conditioning Symposium: December 27-28, University of Pennsylvania, Philadelphia, Pa. Under auspices of the Division of Industrial and Engineering Chemistry, *American Chemical Society.* Symposium Chairman, D. B. Keyes, Department of Chemistry, University of Illinois, Urbana, Ill.

Fifth International Heating and Ventilating Exposition: January 24-28, 1938, Grand Central Palace, New York, N. Y. Manager, Charles F. Roth, International Exposition Co., Grand Central Palace, New York, N. Y.

American Society of Heating and Ventilating Engineers: Annual meeting, January 24-28, Biltmore Hotel, New York, N. Y. Secretary, A. V. Hutchinson, 51 Madison Ave., New York, N. Y.

National Warm Air Heating and Air Conditioning Association: Winter convention, January 25-26, Roosevelt Hotel, New York, N. Y. Managing Director, Allen W. Williams, 50 W. Broad St., Columbus, Ohio.

American Society of Refrigerating Engineers: Annual meeting, January 25-27, Roosevelt Hotel, New York, N. Y. Secretary, David L. Fiske, 37 W. 39th St., New York, N. Y.

Recent Trade Literature

For your convenience in obtaining copies of bulletins, see coupon on page 154

No. 2568. CAST IRON PIPE: United States Pipe and Foundry Co., Burlington, N. J. 24 p. booklet on "Super-de Lavaud" cast iron pipe, the advantages of which are listed as long life, great resistance to impact, high factors of safety, uniformity, and ease of installation. The method of manufacture, including the centrifugal casting in a metal mould, is described briefly. Standard specifications are given, and attractively presented tables of dimensions and weights are included. General tables and formulas of useful pertinent information complete the book.

No. 2569. COLD AIR FACES: Independent Register Co., 3757 E. 93rd St., Cleveland, Ohio. 6 p. circular describing "Fabrikated" cold air faces with 82 per cent open area, showing the various styles and giving selection tables and list prices.

No. 2570. CONTROLS: Minneapolis-Honeywell Regulator Co., 2701 Fourth Ave., S., Minneapolis, Minn. 48 p. condensed catalog and price list containing a complete arrangement of all this company's controls and control systems, including new "National" pneumatic controls and "Brown" indicating, recording and controlling instruments. Several new price changes and instruments are incorporated and the various instruments are illustrated and carefully described.

No. 2571. CONTROL VALVES: Hancock Valve Div., Manning, Maxwell & Moore, Inc., Bridgeport, Conn. 8 p. bulletin on "Flocontrol" valves, illustrating and describing their features, listing applications, and giving dimension tables and list prices. Relative capacities of the various sizes are shown.

No. 2572. CONVECTORS: Trane Co., La Crosse, Wis. 24 p. bulletin on this company's non-ferrous convectors, listing and describing their ten advantages, discussing applications in vapor and vacuum, hot water, orifice, and one pipe steam systems, and in air conditioning. Design and construction is described and numerous installations are listed.

No. 2573. DIAPHRAGM MOTOR VALVES: American

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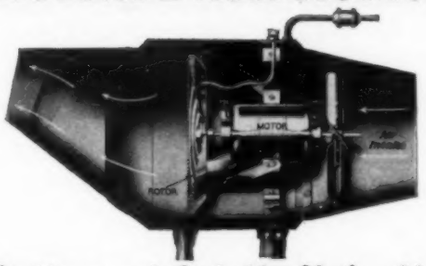

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Approved Bronze Valves

Schaeffer & Budenberg Instrument Div., Manning, Maxwell & Moore, Inc., Bridgeport, Conn. 24 p. bulletin on "American" diaphragm motor valves, describing constructional features in detail, illustrating and giving data on the various types. Technical data of pertinent interest are included, and capacity charts for air, gas, steam and liquids are reproduced.

No. 2574. FANS AND BLOWERS: Autovent Fan & Blower Co., 1805-25 N. Kostner Ave., Chicago, Ill. Circular describing briefly this company's complete line of propeller fans, blowers, automatic louvers, fan houses, and unit heaters.

No. 2575. GAS TORCHES AND FURNACES: Insto-Gas Corp., 1900 E. Jefferson Ave., Detroit, Mich. Circular describing torches, furnaces and cylinders for supplying portable heat for thawing frozen pipes, melting metals, removing paint, etc. Equipment for installing soldered fittings on copper pipe is also illustrated and described.

No. 2576. HARD FACING: The Linde Air Products Co., Unit of Union Carbide & Carbon Corp., 30 E. 42nd St., New York, N. Y. 8 p. booklet on steel hard facing procedure, giving detailed instructions for applying the hard facing material, "Haynes Stellite," to steel wearing surfaces.

No. 2577. HEATING CALCULATOR: Crane Co., 836 S. Michigan Ave., Chicago, Ill. Heating calculator available to contractors who specify this company's equipment, designed to simplify computation of how much radiation and how much boiler capacity are needed to maintain various structures at the proper temperatures.

No. 2578. HOSE: United States Rubber Co., 1790 Broadway, New York, N. Y. 48 p. catalog on hose for various industrial purposes including air, welding, and water, illustrating types of construction and giving detailed information on the various kinds. A section is included on hose couplings and fittings, and another section is devoted to flexible rubber pipe and its uses.

No. 2579. INSULATION: Armstrong Cork Products Co., 994 Concord St., Lancaster, Pa. Issue of "The Armstrong Insulator" including a description of the 5000 ton central refrigeration system supplying chilled water for air conditioning government buildings in Washington, D. C., and describing the use of corkboard insulation and cork pipe covering on this project.

No. 2580. INSULATION: Johns-Manville, 22 E. 40th St., New York, N. Y. 16 p. booklet on this company's products for heating and plumbing, including pipe coverings, range boiler jackets, warm air duct insulation, miscellaneous insulations, sheets and blocks, insulating cements, "Transite" flue pipe, packings, and refractory cements.

No. 2581. OIL HEATING UNITS: National Radiator Corp., 221 Central Ave., Johnstown, Pa. 16 p. booklet of specifications on this company's oil heating units, describing them in detail, their constructional features, and giving dimension and installation data.

No. 2582. PACKINGS: United States Rubber Co., 1790 Broadway, New York, N. Y. 112 p. catalog of packings, featuring tables of packing recommendations for various services and including detailed information on them. Sheet packings, gaskets, rod and plunger packings, hydraulic packings, flax and jute packings, locomotive packings, specialized packings for oil well rotary drilling, pump valves and miscellaneous packings are covered. A 12 p. section of engineering data contains useful information and instructions for the proper installation and care of packings.

No. 2583. PIPING CALCULATIONS: Midwest Piping & Supply Co., Inc., 1450 Second St., St. Louis, Mo. 12 p. bulletin devoted to a simplified method for calculation of pipe wall thickness for various pressures and temperatures which is based on A. S. T. M. specifications and the A. S. A. code for pressure piping. The method is clearly described, examples of its use are included, and three full page tables show comparisons of standards for pipe wall thickness.

No. 2584. PRESSURE REGULATORS AND RELIEF VALVES: Watts Regulator Co., 250 Lowell St., Lawrence,

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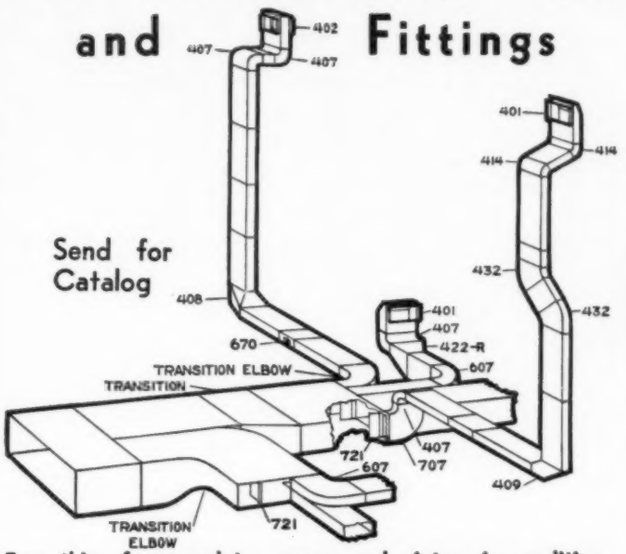

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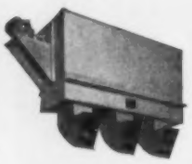

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Mass. 20 p. catalog on relief valves, pressure regulators, low water cut-offs, boiler water feeders, hot water heating systems, and hot water heating regulators. Detailed information on the various equipment and its advantages of construction is given, and applications of the devices are indicated.

No. 2585. REGISTERS AND COLD AIR FACES: Auer Register Co., 3608 Payne Ave., Cleveland, Ohio. Circular describing new "DuraBilt" floor registers and cold air faces with cross locked construction for high strength.

No. 2586. REGISTERS AND GRILLES: Waterloo Register Co., 2520 E. 4th St., Waterloo, Ia. 28 p. catalog of "Air Master" registers and grilles for air conditioning, illustrating and describing many types and showing diffusing fin arrangements for fixed directional flow. Information is included on frames and their installation, damper arrangements for grilles, ventilators for doors, walls and partitions, and corner turns for ducts. Tables of characteristics of various grille combinations are presented, and information is given on selection of grilles.

No. 2587. RELIEF VALVES: Cochrane Corp., 3161 N. 17th St., Philadelphia, Pa. 16 p. bulletin on multiport relief valves designed to provide an effective safety valve for exhaust steam heating systems, as well as for high pressure systems in the process and power field. The valves have several valve discs and their applications, advantages, and design details are discussed.

No. 2588. SPRAY SYSTEMS: Binks Mfg. Co., 3106 W. Carroll Ave., Chicago, Ill. 60 p. catalog covering complete line of spray painting and finishing equipment, spray guns, pressure painting outfits, spray booths, air compressors, pressure material tanks, hose and connections, regulators, circulating systems and accessory equipment.

No. 2589. STAINLESS STEEL ELECTRODES: Page Steel and Wire Div., American Chain & Cable Co., Inc., Monessen, Pa. 12 p. booklet on stainless steel electrodes containing information on the various grades of stainless steels and the procedure for welding them.

No. 2590. STEAM PURIFIERS: Cochrane Corp., 3161 N. 17th St., Philadelphia, Pa. 12 p. bulletin on steam purifiers and their advantages in eliminating damage caused by the presence of moisture and solid impurities in steam. Construction details and styles are described and individual piping layouts are presented.

No. 2591. STEAM SPECIALTIES: Watts Regulator Co., 250 Lowell St., Lawrence, Mass. 8 p. catalog of steam specialties including pressure regulators, reducing valves, pump governors, boiler feedwater regulators, heat interchangers, and numerous other items of equipment.

No. 2592. STEAM TRAPS AND HOOK-UPS: Sarco Co., Inc., 183 Madison Ave., New York, N. Y. 32 p. "hook-up" book devoted to correct steam trap selection and application which has been based on an accumulation of data over a 25 year period. The principle sections are: Method for calculating trap sizes; hook-ups and descriptions of various types of heating systems, including unit heaters and air conditioning; hook-ups for process steam applications; hook-ups for steam headers; hook-ups for temperature control; and basic descriptions of fundamental characteristics of various types of steam traps, temperature regulators and steam accessories. Fifteen full pages of diagrams are included and a number of examples worked out in detail are presented with the information necessary to solve them.

No. 2593. STEEL PIPE: Youngstown Sheet and Tube Co., 602 Stambaugh Bldg., Youngstown, Ohio. 166 p. steel pipe booklet prepared as a special service to users of commercial steel pipe and including a wealth of data on various types of pipe, tables of weights and dimensions, weight per foot, test and working pressures and thickness, and technical data useful to the engineer in designing plant and building piping systems. A section is devoted to forged steel unions and the booklet concludes with an extensive illustrated section showing the step-by-step manufacture of tubular steel products from ore mines to the finished pipe.

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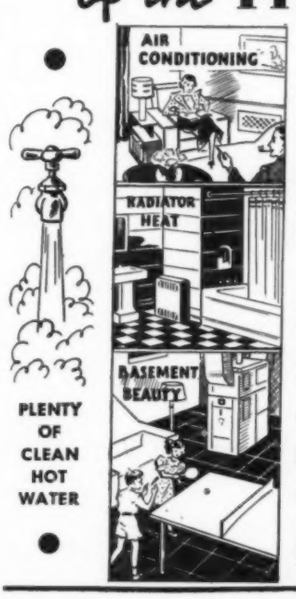
NEW YORK OFFICE: 101 PARK AVE.

Patterson Indestructo Copper-Lined Hot Water Heaters

HOME OWNERS want the 4 BENEFITS of the FITZGIBBONS



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Ozite HAIR FELT

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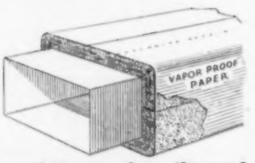

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Also — OZITE HAIR FELT AIR DUCT LINING and DUCT INSULATION for all Sound, Heat and Cold Insulation purposes.

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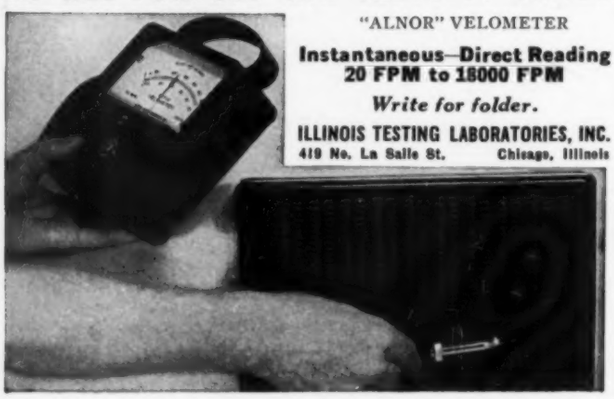

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Heating, Piping and Air Conditioning,
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Please ask the manufacturer to send me more information about the equipment mentioned under the following reference numbers in "Equipment Developments" and "Recent Trade Literature." (Circle the numbers in which you are interested):

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1339	1340	1341	1342	1343	1344	1345
1346	1347	1348	1349	1350	1351	1352
1353	1354					
2568	2569	2570	2571	2572	2573	2574
2575	2576	2577	2578	2579	2580	2581
2582	2583	2584	2585	2586	2587	2588
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2596	2597	2598	2599	2600		

Name .....Title.....

Company .....

Address .....

City .....State.....

No. 2594. STOKERS: Bardes Stoker Works, Div. of E. H. Bardes Range and Foundry Co., 2619 Colerain Ave., Cincinnati, Ohio. 16 p. catalog on this company's stokers of various models, giving capacities and information on their design, construction and engineering. Special attention is given to the spiral ram stoker and this feature is discussed in particular detail.

No. 2595. THERMOSTATS: Minneapolis-Honeywell Regulator Co., 2701 Fourth Ave., S., Minneapolis, Minn. Booklet entitled "And Then . . . We Turn On The Heat" describing why the heat accelerating thermostat can maintain stabilized room temperature, explaining what heat acceleration is, and how it works when applied to thermostatic control. Diagrams of the heat accelerated thermostat circuit are shown and clearly described, and pictures from a new sound film are reproduced.

No. 2596. UNIT HEATERS: Trane Co., La Crosse, Wis. 8 p. bulletin on new "Projection" unit heater for uniform heating in factories, stores, offices, halls, lobbies, garages and similar applications, describing features and principle of operation, including the new fan and circular coil. Examples of possible fuel savings are included, and roughing in dimensions and capacity tables are presented. A similar bulletin is devoted to the multiple unit of similar design, including capacity and dimensional data. Also, a 24 p. bulletin on "Torridor" blower type unit heaters, with special attention given to design features, bypass control, and construction. An extensive section is included on selection, location of units for various applications, determining special capacities, hot water capacities, wiring diagrams, controls and piping.

No. 2597. VALVE LUBRICATION: Texas Co., 135 E. 42nd St., New York, N. Y. Issue of "Lubrication," Vol. 23, No. 9, featuring a discussion of valve lubrication and including information on the following topics: Function of the lubricant, plug valves, gate valve lubrication, valve sticking, toggle valves, and gear mechanisms.

No. 2598. VALVES: Hancock Valve Div., Manning, Maxwell & Moore, Inc., Bridgeport, Conn. 4 p. bulletin on the "Duravalve" with integral "Stellite" seat for 1500 lb and 950 F, describing features briefly and showing a bill of materials.

No. 2599. WATER COOLING EQUIPMENT: Binks Mfg. Co., 3106 W. Carroll Ave., Chicago, Ill. Water cooling equipment catalog comprising 16 p. bulletin on induced draft spray cooling towers, 12 p. bulletin on forced draft cooling towers, 16 p. bulletin on atmospheric spray cooling towers, and 24 p. catalog on this company's line of industrial spray nozzles for water cooling, air washing and air conditioning. Engineering data are included and tables of capacity, dimensions, weights, etc. are shown.

No. 2600. WELDING: Hobart Bros. Co., Canal Lock Sq., Troy, Ohio. 26 p. catalog on arc welding with new 40 volt "Simplified" arc welder, describing and illustrating features and the various types of this equipment.